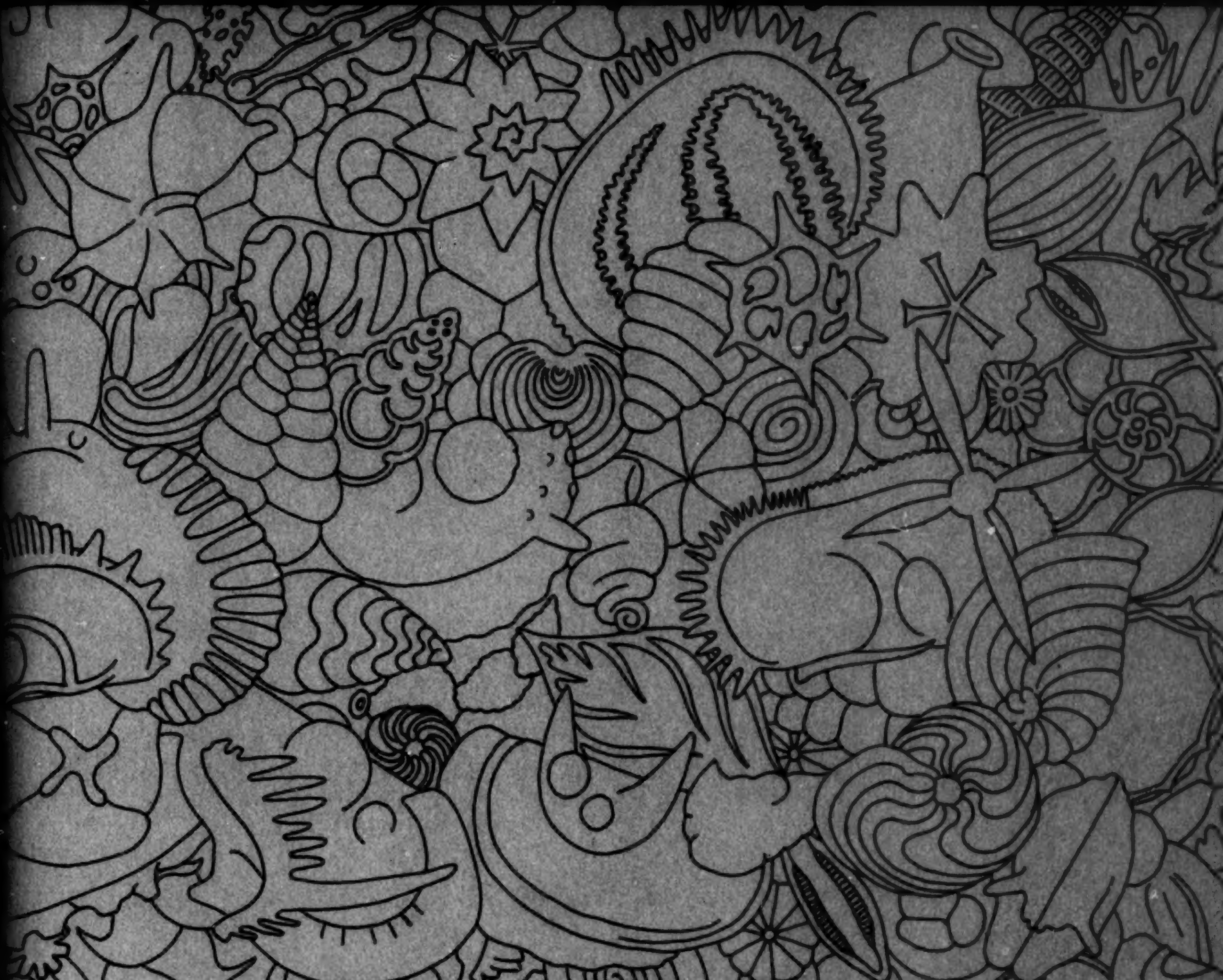

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The new subscription price

When plans were made to publish Micropaleontology, it was realized that publication costs would inevitably exceed income from subscriptions for the first two or three years. This situation seemed unavoidable even if the subscription price were high. As a rather low introductory price appeared desirable, the anticipated deficit promised to be substantial.

Three numbers have now been published, and most micropaleontologists have had an opportunity to examine and evaluate the quarterly. Although subscriptions are coming in at a very satisfactory rate, the maximum will probably not be reached for two or three years. Unit costs have been more or less stabilized, however, and consequently a more realistic subscription price is in order.

In determining what this price should be, consideration has been given to present costs and income, as well as to the total number of subscriptions anticipated in two years and the cost of servicing them. Consideration of these factors has led us to fix the subscription price for next year at $8.00. This charge will not cover the cost of publishing the quarterly for the number of subscriptions expected next year. It will, however, materially reduce the deficit, and it is believed that it may well make the publication self-sustaining when the maximum number of subscriptions have been received. In the meantime, the subsidy will have to be continued.

We are now certain that the quarterly can eventually be self-supporting without danger to standards and without an exorbitantly high subscription charge. It will be necessary to secure the maximum number of subscriptions, however, and all present subscribers are asked to help us reach that goal. With their help, we are confident that it can be attained without undue delay.

THE EDITORS

ABSTRACT: *Indurated Upper Cretaceous globigerinal limestones have been studied in randomly oriented thin sections providing sections of numerous specimens of* Globotruncana. *The ratio between the numbers of sectioned* Globotruncana *individuals showing one peripheral keel and of those showing two or more such keels is almost constant for any stratigraphic horizon, regardless of facies, within northern Iraq. The ratios vary progressively with age in any vertical sequence, thus providing a rather precise key to stratigraphic position within the age-limits of the formations considered. Detailed observations have been restricted to the Maestrichtian and upper Campanian sediments of northern Iraq. It is possible that the values of the ratios may be of worldwide stratigraphic significance, and also that the progressive change may be continuous through sediments of Cenomanian to Maestrichtian age.*

Close zonation of Upper Cretaceous globigerinal sediments by abundance ratios of Globotruncana species groups

H. V. DUNNINGTON
Iraq Petroleum Company, Limited
Kirkuk, Iraq

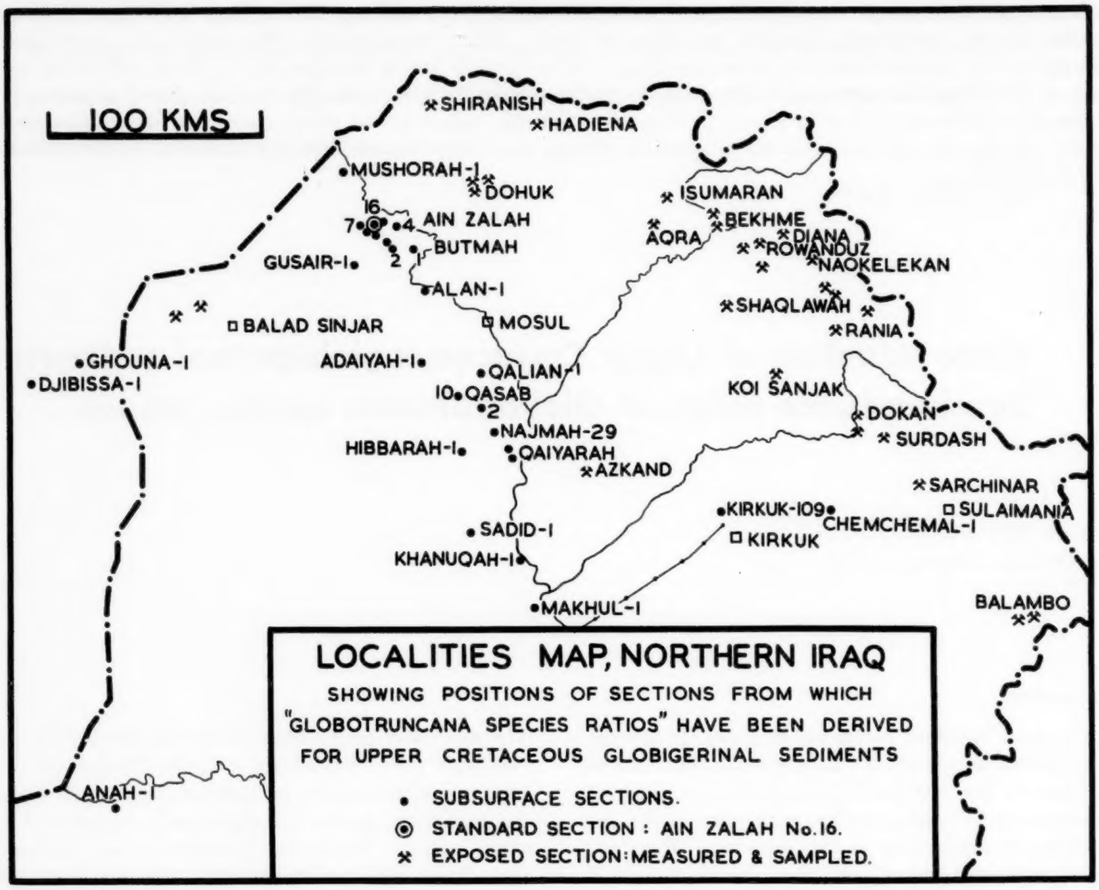
INTRODUCTION

Globigerinal limestone sediments of upper Campanian to Maestrichtian age reach a known thickness of almost 4000 feet in the Ain Zalah area of northern Iraq. A palaeontological zoning method was required for fine stratigraphic subdivision of this sequence. The rocks are of economic interest, as they are the reservoir formation for oil accumulations in the Ain Zalah and Butmah fields (E. J. Daniel, 1954). They vary considerably in thickness between adjacent anticlinal structures, partly because of original variations in deposited thicknesses, and partly as a result of uneven erosional loss during the Cretaceous-Tertiary break.

In the Ain Zalah area, the rocks are not exposed at surface, but adequate material for their study is available from subsurface sections on the anticlinal structures of Jebel Ain Zalah, Jebel Butmah, Mushorah Dagh, Jebel Alan and Jebel Gusair. They outcrop widely in the mountain area of Kurdistan, north and east of Ain Zalah, where they pass laterally into reef limestones and into flysch-like clastic formations. The upper parts are exposed in Jebel Sinjar, to the west of Ain Zalah. Numerous additional subsurface sections have furnished material for study. The locations of the principal sections from which sample-suites have been considered are indicated on the map (text-fig. 1).

The sediments encountered in the Ain Zalah wells are indurated marly limestones, with 80-90% calcium carbonate, containing rich foraminiferal faunas, in which the planktonic genera are abundantly represented by many species. Benthonic foraminifera are generally rare. Spore and pollen analyses have not been attempted. Other microfossils are very rare or absent. Because the rocks are not easily disaggregated by any of the usual laboratory methods, normal zonation by reference to the distribution of separated microfossil species is impracticable. Sample studies have been based principally on examination of large numbers of thin sections. Restriction of observation to two randomly oriented dimensions prohibits the full identification of many foraminifera, so that establishment of ranges of all represented species is impossible. The planktonic foraminifera which lend themselves to specific identification from sectioned rocks do not show sufficient differentiation, within the age-limits of the sequence, to permit any fine subdivision of the sections.

S. W. Tromp's method of "quantitative generic determinations" has been tested but found wanting, in that his findings cannot be directly applied to northern Iraq. Tromp (1952, and earlier papers) attributed



TEXT-FIGURE 1

MAP SHOWING LOCALITIES MENTIONED IN THE TEXT

isochronous age significance to certain quantitative relationships between particular genera, and to variations in absolute abundance of certain groups of foraminifera encountered in Turonian and Senonian sediments of Egypt and Turkey. Comparable quantitative relationships and variations in abundance of the stipulated genera, observed in samples from northern Iraq, relate to depositional-environmental factors, and not to age, so that the method cannot be credited with any value in long-distance correlation into Iraq.

Full numerical evaluation of relative abundance of selected planktonic species has been used to a limited extent in short-distance correlations, though small variations in lithology are more readily discernible and probably more dependable for this type of work. The number of thin sections which must be scrutinized in order to obtain dependable evaluations is so large that the method cannot be applied to very large numbers of samples. Moreover, its value in long-distance correlation is not yet established.

During the early phases of study of material from Ain Zalah wells, it was observed that, apart from stratigraphically localized abundances or rarities of benthonic species, and from fluctuations in absolute abundance of foraminifera, the most obvious change apparent in the fauna is the increasing abundance of *Globotruncana stuarti* (de Lapparent) and similar *Globotruncana* species, relative to other *Globotruncana*

species, as the sequence is ascended. This change in relative species-dominance through the Campanian and Maestrichtian has been noted, in qualitative fashion, by Renz (1936), Tschachtli (1939), Bolli (1945, 1951), Glaessner (1945), and other authors, who have treated of other areas.

It appeared possible, though at first improbable, that the qualitatively observed change in relative abundance of unicarinate and multicarinate species of *Globotruncana* might be quantitatively progressive, and might provide an approximate index to the stratigraphic positions of samples in the succession. Detailed investigation of samples from Ain Zalah wells, and from many other localities, has shown that there is in fact a close and simple relationship between the relative abundance of unicarinate and multicarinate specimens encountered in large-area thin sections of any sample, and the stratigraphic position of that sample.

It has been found convenient to express determinations of relative abundance by means of a ratio, which may be termed the "S/O" ratio, in which "S" is the number of intersected specimens of *Globotruncana* species showing only a single peripheral keel, and "O" is the number of intersected specimens showing two or more peripheral keels.

METHOD OF DERIVATION OF "S/O" RATIOS

The "S/O" ratio for any sample is obtained simply by visual counting of the numbers of unicarinate and multicarinate *Globotruncana* specimens intersected in thin section, and by subsequent division of the former by the latter. The ratios are entirely empirical, and they cannot be transposed into numbers of proportions of any particular species making up particular populations. In the interests of uniformity, certain rules for admission of sections in one or other of the counted categories are rigidly obeyed:—

1) only vertical or subvertical sections are counted;

2) no section is included in the census unless it shows the peripheral portion of one chamber and cuts at least two chambers;

3) sections which show different (unicarinate and multicarinate) characters on opposed peripheries are classed as multicarinate;

4) sections which show mixed features on inner and outer chambers are classed according to the visible characters of the outer whorl.

Ratios are normally based on counted populations of at least 500 sectioned specimens, and preferably on populations of several thousand individuals.

In any set of thin sections there appear border-line individuals, the disposal of which in one or other category during counting is largely fortuitous. The existence of this indeterminate component of the population introduces an element of personal evaluation into the counting, which may result in unconscious bias of the ratios toward interpretations favoured by the operator. The possible effects of such directed bias may be avoided by ensuring that the operator is ignorant of the position and significance of the sample until the counting operation is completed; this has been done by examining thin sections labelled with coded numbers and in mixed order, and also by examination of batches of coded thin sections of the samples under investigation, mixed with batches of thin sections for which ratios have already been derived. The last-mentioned device serves the secondary purpose of providing a check on the consistency of the operator and on the reproducibility of the ratios. However, all such bias-reducing subterfuges involve added tedium in a counting operation which is inevitably very fatiguing.

In current practice, each population is counted three times, on different occasions, first with conscientious omission of all ambiguous sections which are admissible under the rules already stated; then with deliberate inclusion of all possible sections in the unicarinate category, and finally with deliberate inclusion of all possible sections in the multicarinate category.
The totals of individuals counted on the three occasions are seldom identical. The numbers of ambiguous sections recognized for the two biased counts usually differ slightly. Unless the counting is faulty, however, the ratio derived from the first count should be close to the adopted "S/O" value, which is derived from division of the sums of the totals of all three counts. Experience has shown that "S/O" values obtained by such triple counting are almost identical with those derived from multiple counts of coded samples, whilst the two deliberately biased counts permit some evaluation of margin of error in determination, which is not allowed by other methods.

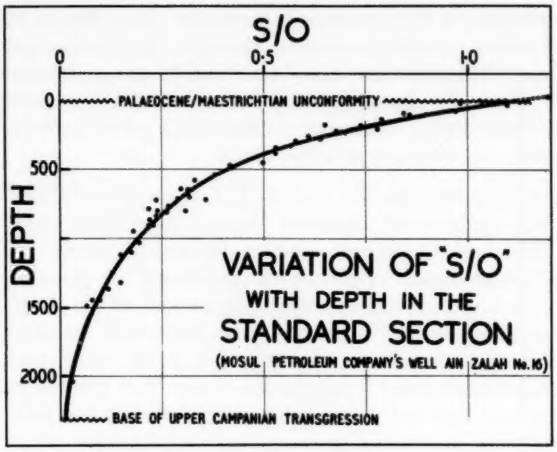
Because of the dominance of the populations by single-keeled forms in the younger sediments, and by multicarinate forms in the older sediments, the confusing effects of ambiguous forms on the derived "S/O" values are greater at the top and bottom than in the middle parts of the formations.

Checked consistency of ratios determined for identical large populations, counted at different times by the writer, suggests that allowance for inconsistency

should be of the order of ± 5% "S/O" for counts of 500 specimens, falling to about ± 2½% "S/O" for counts of over 3000.

Reproducibility by different observers has not been examined with any thoroughness, though Dr. R. C. van Bellen has obtained values for "S/O", from counting of large-population samples, which agree with ratios derived independently by the writer to within 10 per cent on "S/O" values of the order of 0.15, and to within 5 per cent on "S/O" values in the range 0.2-0.3.

Thin sections are examined under a binocular microscope, by transmitted light, manipulation on the glass stage being preferred to laborious searching with a mechanical stage-fitting. As individual cross sections are categorized and counted, they are "blacked out," on the cover glass, by water-soluble ink applied with a fine-pointed pen. Mechanical counting aids have not been used.



TEXT-FIGURE 2

Relationship between values of "S/O" and stratigraphic position in the "standard section" of the upper Campanian and Maestrichtian globigerinal sediments (Mosul Petroleum Company's Ain Zalah well no. 16).

VARIATION OF "S/O" WITH STRATIGRAPHIC POSITION

Text-figure 2 illustrates the relationships found between "S/O" values and stratigraphic positions in a single subsurface section. Depths shown are below the eroded top of the Upper Cretaceous in the Mosul Petroleum Company's Ain Zalah well no. 16, which is adopted as the standard section for studies of this type in northern Iraq. Most of the "S/O" values plotted were derived from core material, but some were based on sections of cuttings which appear to be almost free from contamination by cavings. Most values were obtained by triple counting of populations of more than 500 individuals, and several represent counted populations of several thousand individuals.

The available "S/O" values show progressive increase from bottom to top of the section. The smoothed curve has been inserted arbitrarily, by hand. The average departure in depth of observed "S/O" values from the smoothed curve is about 40 feet, the maximum departure is about 140 feet, and the maximum departure for values obtained from core samples is less than 90 feet. Full statistical treatment of results has not been attempted because enquiries into consistency and reproducibility are still incomplete.

The data illustrated are considered adequate to support the conclusion that "S/O" varies more or less progressively with stratigraphic position in this well. It is further postulated that the decrease in abundance of multiple-keeled *Globotruncana* individuals relative to single-keeled forms was by nature gradual and continuous. The smoothed curve of text-figure 2 is therefore accepted as representing, with some approximation, the change in relative abundance of the two species groups with depth, and non-quantitatively with age, in this "standard section."

HORIZONTAL CONSTANCY OF "S/O"

The findings illustrated in text-figure 2 suffice to suggest the possibilities for local correlation purposes which may be inherent in the smoothed-curve variation of "S/O" with depth. But variations in ratio might relate to variation in water depth, temperature, salinity or other environmental factors, rather than to variations in age. The progessive variation in "S/O" could be a reflection of progression variation in some such factor. Alternatively, the variation could be compounded of variations resulting from age-controlled biological factors, on the one hand, and from environmental facies on the other.

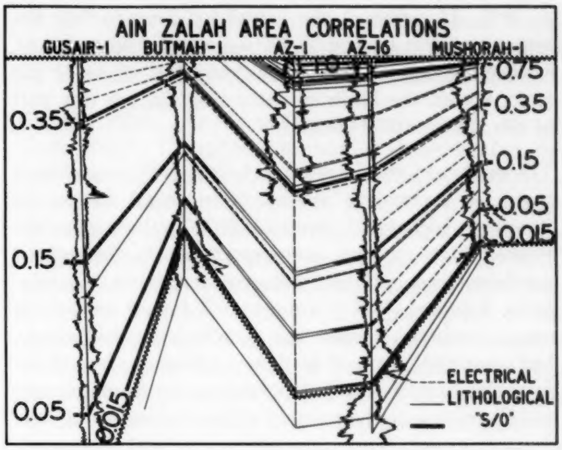
From *a priori* considerations, *Globotruncana*, in common with other planktonic foraminiferal genera, should have been rather insensitive to minor environmental changes during life. After death, distribution of tests should have been wide, because of the planktonic life-habit, so that closely localized variations of any importance would not be anticipated. The possibility remains that regional variations in "S/O" values for contemperaneous faunas might be of important magnitude.

Enquiry into the age-significance of "S/O" values has been somewhat haphazard, because of the rare occasions upon which an independent time-standard could be utilized to check the relative ages of samples of which the "S/O" values have been ascertained.

Preliminary investigations of well and outcrop samples from many areas, including Ain Zalah, served to show that in all sections the relationships between "S/O" and depth can be expressed by curves rather similar to that of text-figure 2, in which "S/O" increases with increasing increments as the sequence is ascended. The slopes of the curves for any specified "S/O" interval vary within wide limits in different sections. The origin of the curve ("S/O" = 0.15 at 2300 feet, in text-figure 2) for different sections varies within wide limits, according to the age of the underlying sedimentary unit and to the nature of the contact.

Within the Ain Zalah—Mushorah—Gusair—Butmah area, subsurface sections can be quite closely correlated on the evidence of electric logs and by independent lithological criteria. Both lithological and electric-log correlations can be regarded as "time-correlations." Both are tied closely to occurrences of thin detrital limestones, which are made up of finely comminuted orbitoidal debris, sponge spicules, and other macrofossil elements. These detrital intercalations, which are rare, show graded bedding, suggesting that they were deposited from slurries caused by powerful tsunami. Whether or not they had this origin, it may be accepted that each detrital limestone was deposited simultaneously over the entire area of its occurrence. When "S/O" values are derived through several sections, and "S/O" correlations are plotted, "S/O" correlation lines either lie parallel with correlation lines based on lithology or on electric logs, or they fall between diverging lines of these origins (text-fig. 3). Within the controlled area, there is no discernible systematic variation in age of samples which have the same "S/O" value. The distances through which age-constancy of "S/O" values is thus confirmed are about 45 km. along the facies trend-lines, but only 25 km. perpendicular to such trends. Electric-log correlations cannot be carried beyond the limits of the Butmah—Gusair—Mushorah triangle, and further investigation of the relationship between age and "S/O" values must depend upon other types of evidence and argument.

In the Ain Zalah area, and also in the Djibissa area of northeastern Syria, the upper Campanian globigerinal sediments are underlain by lower Campanian rocks which are characterized by a peculiar and restricted faunifacies, dominated by the problematical organism *Oligostegina*. These lower Campanian sediments are judged to be the deposits of an enclosed sea, in which salinity or other conditions were abnormal. The sequence culminates in a thick glauconitic unit in northeastern Syria, and in a minor diastem in the Ain Zalah region. The initial sediments of the upper Campanian carry a full marine fauna, characterized by normal planktonic foraminifera, in all areas. The sudden incursion of normal faunas is taken to represent a phase of transgression, which terminated the isolation of the restricted lower Campanian basin almost instantaneously over the entire area of the basin. The "S/O" values derived for basal samples of the transgressive upper Campanian in the Ain Zalah wells (0.015 ± .005) are almost identical with those derived for the earliest comparable sediments in the Djibissa and Ghouna wells (0.012). In this particular case, essentially contemporaneous sediments in areas separated by 150 km. obliquely across facies trend-lines have closely comparable "S/O" ratios.



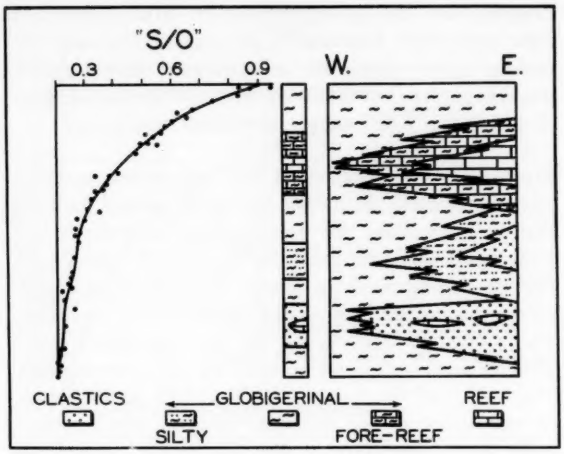
TEXT-FIGURE 3

Parallelism between correlations based upon electric-log and lithological criteria, and correlations based on "S/O" ratios, in the Ain Zalah — Mushorah — Gusair — Butmah area.

In the exposed Upper Cretaceous sections of Jebel Sinjar, 90 km. west-southwest from Ain Zalah, there is a thin ammonitiferous bed which yields the ammonite *Bostrychoceras polyplocum* (Roemer). Other ammonites of the *B. polyplocum* zone occur commonly above and below this horizon, but the zone fossil is seemingly restricted to a narrow vertical range. In Gusair well no. 1, *B. polyplocum* has been recovered in core samples which yield an "S/O" value of 0.23

± 0.02. At exposure, the correlated horizon falls between samples having "S/O" values of 0.26 and 0.22, confirming essential time-constancy for values of the ratio, within the limits of determination, for this part of the stratigraphic section.

The evidences cited are taken to justify the conclusion that, for sediments of the globigerinal facies, all samples which yield identical "S/O" values were deposited more or less contemporaneously throughout northern Iraq and into adjacent territories. Correlations between "S/O" values and faunal ranges in many localities support this conclusion qualitatively, but quantitative proof or denial cannot be hoped for from this type of correlation, because the faunal ranges are themselves only vaguely defined in terms of age.



TEXT-FIGURE 4

Schematic illustration of the relationships of "S/O" values and lithofacies found in areas of interdigitation of globigerinal marls with fore-reef-shoal limestones and with flysch-type clastics. Though the gradient of the "S/O-with-depth" curve varies, probably in response to changes in rate of sedimentation, there is no significant increase or decrease in values across facies boundaries.

INSENSITIVITY OF "S/O" TO FACIES

It has been suggested that the progressive change in "S/O" with depth (i.e., with age) in all sections considered might possibly reflect selective control of the *Globotruncana* fauna by environmental factors. There is generally no difficulty in finding, in any section, some slight progressive lithological change, which might be an independent reflection of such environmental factors. Thus, in the Ain Zalah well sections, there is an overall increase in the abundance of the planktonic foraminifera from bottom to top of the sequence, linked with an overall increase in the average size of the individuals making up the faunas. These progressive changes are linked with evidence suggesting progressive shallowing following early and rather rapid transgression, and also progressive slowing in the rate of sedimentation. The rate of sedimentation controls the gradient of the "S/O-with-depth" curve (text-fig. 2), whether or not "S/O" is time-constant for any horizon. It is possible that the change in proportion of single-keeled to multiple-keeled *Globotruncana* individuals might be occasioned or at least conditioned by changes in depth of water, or in turbidity, or temperature, or other environmental factors.

Fortunately there is material in northern Iraq which permits investigation of the possible importance of environmental controls. The Upper Cretaceous sediments of different facies are interrelated, in a complex manner, within the region. It is possible to select sections, in one or another area, in which the most significant environmental factors occur in a sequence which is reversed relative to that in the standard section. Thus, whilst Ain Zalah sections show progressive shallowing, progressive faunal enrichment, and progressive increase in size of the planktonic foraminifera, other sections show progressive deepening, progressive faunal impoverishment and upward diminution in size of individuals. Had the environmental factors linked with richness and size of fauna and progressive deepening exercised a dominant sway upon the "S/O" composition of the fauna, the ratios should decrease, with decreasing age of the samples, in sections where the normal environmental progressions are encountered in reversed order. Decreasing values of "S/O" with decreasing age are not found in such sections. Most of the obvious environmental factors have been critically examined by appeal to this type of evidence, without any direct relationship between "S/O" values and any environmental factor coming to light. In all such arguments, the possibility remains that the environmental factors may affect the gradient of the "S/O-with-depth" curve importantly, but not sufficiently to produce a reversal in gradient.

The effects of some of the more potent environmental factors can be assessed by observation in a limited number of cases, and for limited parts of the "S/O" range, in localities where "normal" marine globigerinal limestones interdigitate or grade into other types of sediments. The globigerinal sediments pass laterally by interdigitation into flysch-type clastics in the northeastern part of the region considered, and similarly into fore-reef-shoal limestones in the exposed areas of

the Kurdistan mountains (Henson, 1950), and to the south of Ain Zalah. In a few cases of each type of interdigitation, "S/O" ratios have been derived for full sample-suites covering normal globigerinal sediments, gradational sediments, and fore-reef-shoal limestones or clastics. The relationships found are illustrated schematically in text-figure 4.

The approach of conditions favouring neritic limestone deposition on the one hand, and silt and sand deposition on the other hand, have a negligible effect upon the balance of populations as measured by "S/O" values. The gradients of the "S/O-with-depth" curve for such sequences of mixed sediments vary somewhat, presumably as a reflection of the different rates of sedimentations associated with the different facies. But there is no appreciable lateral displacement of the "S/O-with-depth" curves corresponding to particular lithologies, and no reversal of that increase in "S/O" values with decreasing age which is encountered in unbroken globigerinal-limestone sections.

ACCURACY OF "S/O" CORRELATIONS AND AGE DETERMINATIONS

In the "standard section" of Ain Zalah well no. 16, the difference between the depth of origin of the sample and the depth shown on the "S/O-with-depth" curve for the "S/O" value of the sample averages only 40 feet. Maximum departures found are 140 feet for cuttings samples and 90 feet for core samples. Departures of the same order of magnitude are found in the cases of samples from other Ain Zalah wells, when related to position in the "standard section."

From experience in operation of "S/O" correlations it may be claimed that a single "S/O" value may be utilized to fix the equivalent position of the sample in the "standard section" to within 50 feet, with 60 per cent probability. This claim presupposes the age-equivalence, throughout the regions, of samples with identical "S/O" values. It also refers only to "S/O" values which have been fully determined by triple counting of populations of 500 or more individual specimens. Where only small populations are available, the derived ratio is naturally less dependable, and correspondingly greater margins of error must be admitted.

The total true thickness of Upper Cretaceous globigerinal sediments remaining in the "standard section" is about 2300 feet. Thus it is claimed that a single "S/O" value suffices to determine the stratigraphic position relative to the standard section to within one-fortieth of the thickness of the formation in the standard section, with a probability of 60 per cent. This is a degree of precision seldom attained by normal palaeontological zoning methods which have been applied in the subdivision of montonous basinal sediments.

In Ain Zalah, the deposits considered range in age from middle Campanian to middle Maestrichtian, the uppermost Maestrichtian being cut out by Tertiary—Cretaceous erosion. Elsewhere in northern Iraq, considerably younger Maestrichtian sediments have survived below the Cretaceous—Tertiary break. "S/O" values for these youngest-known Maestrichtian sediments lie between 3.0 and 4.0. Extrapolation of the smoothed "S/O-with-depth" curve for the standard section suggests that ratios of 3 to 4 would have been encountered some 200-300 feet above the present top of the formation in Ain Zalah, had there been no erosional loss. Even the most complete sections of the formation are terminated by erosion. It may be accepted that the full upper Campanian—Maestrichtian section in Ain Zalah well no. 16 was at least 2600 feet thick prior to erosion. The "S/O" dating method is thought to be sufficiently sensitive to determine ages of samples in empirical time-units to within one-fiftieth of the combined time-duration of the upper Campanian and Maestrichtian stages, with a probability of 60 per cent. This assessment relates to ratios based on counts of large populations. It presupposes age-equivalence, within the area of observation, of samples yielding equal values for "S/O", and it assumes a constant rate of sedimentation throughout the deposition of the sequence. The accuracy of correlation and age determination is somewhat less toward the top and bottom of the formation from its middle portion.

SOME APPLICATIONS OF THE "S/O" DATING METHOD

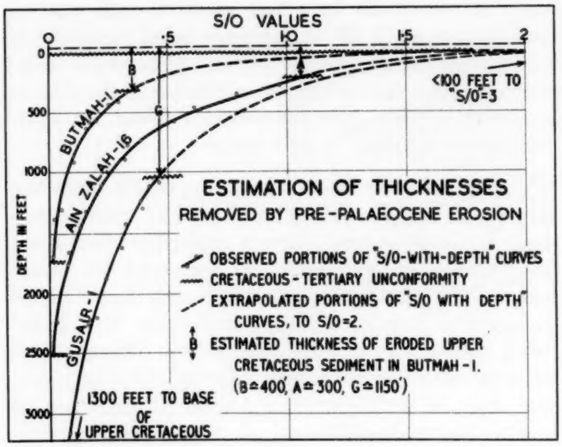
The method of "S/O" correlations has been widely applied during the past few years to a variety of stratigraphic problems encountered in northern Iraq. The earliest application was to the problem of choosing between alternative lithological or electric-log correlations between wells in the Ain Zalah area. Such correlations depended upon the presence of occasional widely-spaced markers of rather similar character in the various well sections. Often, one marker in one well might have been correlated with one of two similar markers in other wells, the rival candidates being separated by one or two hundred feet of section. "S/O" counts at about the depths of the respective "marker" horizons sufficed to indicate with a high degree of probability which correlation was correct. Recent inter-well correlations have been of such quality that this type of application has not been

required. Electric-log correlations have been extensively utilized, of late, to determine the precise correlative position, within the "standard section," of samples from other wells which have yielded "S/O" values. Such interpolated ratio values have served to confirm, adjust and fortify the standard "S/O-with-depth" curve.

The erosional cut-out at the top of the Upper Cretaceous has been mentioned above. The "S/O" values from the highest samples in each section can be utilized as a quantitative guide to the thickness of Upper Cretaceous rocks which has been removed by erosion, though normally this can be expressed only in terms of thickness in the "standard section," and not in terms of thickness removed from the individual sections studied. Thus, the highest "S/O" ratios encountered in the Butmah field, southeast of Ain Zalah, are of the order of 0.32, corresponding with a position on the smoothed "S/O-with-depth" curve some 700 feet below the top of the Upper Cretaceous in Ain Zalah well no. 16. It may be asserted that erosion has removed a section equivalent in age to the uppermost 700 feet of section in Ain Zalah well no. 16, together with the higher Maestrichtian sediments which have also been removed from Ain Zalah.

Observation has shown that, in the great majority of sections studied, the "S/O-with-depth" curves are of approximately the same form as that plotted for Ain Zalah (text-fig. 2). The shape of this typical curve depends upon the rate of sedimentation, which varied from area to area, and upon the rate of change of "S/O" with time, which may itself have varied progressively. However, the slackening of gradient in the upper part of the curve may reflect slowing in sedimentation, and perhaps reflects approach to a base-level of deposition. It is known that in some areas "S/O" ratios of 3 to 4 are yielded below the Cretaceous—Tertiary break. It is therefore practicable to utilize extrapolation methods on any fragmentary "S/O-with-depth" curve, in order to restore the probable thickness of sediments which once intervened between the present top of the Upper Cretaceous and the original top. The application of this extrapolative argument to the Gusair, Butmah and Ain Zalah area sections is illustrated in text-figure 5.

The age of the uppermost remaining Cretaceous in Gusair well no. 1 is greater than that of the topmost Cretaceous samples in the standard section (Ain Zalah well no. 16) by a time-interval corresponding to the topmost 500 feet of the Ain Zalah section. The highest Cretaceous samples in Butmah well no. 1 are older yet, by a time-interval corresponding to that

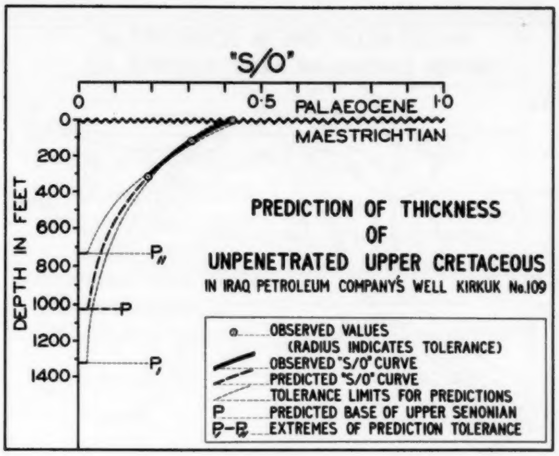


TEXT-FIGURE 5

Estimation of thicknesses eroded from individual sections by extrapolation of "S/O-with-depth" curves to "S/O" = 3.0.

occupied by the deposition of the sediments now lying between 700 and 500 feet below the Palaeocene—Cretaceous unconformity in the standard section. The "S/O-with-depth" curves for the existing Upper Cretaceous sediments in these wells are plotted, and the curves projected for the eroded portions, in such a manner as to bring the extrapolated portions of the curves together at the point where "S/O" = 3. It is then seen that whilst the Butmah section has suffered slightly more loss by erosion than has that of Ain Zalah, the Gusair section has been reduced by almost four times the thickness which has been lost in Ain Zalah.

The justification for employment of this type of extrapolative estimation of thickness eroded must naturally depend upon the tectonic and sedimentational history of the area studied. If intermittent localized structural development prevailed in the area during sedimentation of the globigerinal deposits, or if depositional base-levels were approached in different localities at widely different times, a uniform erosion of the entire area would have left rocks of greatly different ages at the erosional surface. In northern Iraq, "S/O-with-depth" curves, in the uppermost parts of known sections, are usually smooth and regular, without conspicuous increase or decrease in rate of change of gradient. Hence the estimated thicknesses eroded probably bear a close relationship to actual erosional losses.



TEXT-FIGURE 6

Prediction of total thickness of Upper Cretaceous sediments to be encountered in an exploratory well, by downward extrapolation of an "S/O-with-depth" curve based on three "S/O" values derived from the upper part of the sequence.

A second type of extrapolation, of more immediate practical value, has been used to predict the depth at which the base of the Upper Cretaceous would be encountered in exploratory wells which had penetrated only a few hundred feet into the Upper Cretaceous. Kirkuk well no. 109 was such a well, 200 km. from the standard section of Ain Zalah and 180 km. from the nearest complete section through the globigerinal Upper Cretaceous. "S/O" values were obtained for three samples separated by about 150 feet, taken within the uppermost 350 feet of drilled section. On the evidence of the first of these three values, it was stated that the upper part of the sequence, equivalent in age to the highest 600 feet of the Ain Zalah "standard section", has been removed by erosion at Kirkuk. The second and first values together indicated that the "S/O" gradient-with-depth was less steep than in Ain Zalah. In consequence, it was predicted that the total thickness of the Upper Cretaceous would be considerably less than that found in the correlative section in Ain Zalah. The three values together permitted the plotting of a fragmentary "S/O-with-depth" curve (text-fig. 6). Extrapolation of this curve, allowing for margins of error for the three determinations and utilizing the standard "S/O-with-depth" curve of Ain Zalah as a guide to curve-form, was used to predict that the total thickness of the sequence would be found to be 1025 feet, with a depth tolerance of 290 feet in either direction. In fact, the total thickness was confirmed as 1013 feet by further drilling.

The close agreement between predicted and found thicknesses in this case was largely fortuitous, but the successful prediction of the general order of thickness was acceptable as a test of the accuracy of the method. Similar predictions made in other wells have been borne out within appropriate tolerance limits but without attainment of such spectacular accuracy as was shown by the Kirkuk well.

"S/O" findings have been utilized to some extent in palaeogeographic reconstructions. Thus, the "S/O-ages" of the earliest Upper Cretaceous globigerinal limestones in many sections have been utilized to demonstrate that the oldest of such sediments are found in the Ain Zalah—Gusair—Djibissa area, where they follow upon lower Campanian to lower Senonian rocks. Although great transgression appears to have swept from east to west across northern Iraq in later Campanian and Maestrichtian time, the basal sediments of this transgression are older in Ain Zalah than in the eastern parts of Kurdistan, where they lie concordantly but unconformably on eroded Turonian limestones.

Shortly after the onset of the upper Senonian transgression, uplift occurred in an extensive area of Persia. Clastic sediments, largely composed of detritus of radiolarian cherts derived from this uplift, were poured into northern Iraq. The clastics advanced diachronously from east to west, grading into and interdigitating with the globigerinal facies which underlies them. A deep trough, filled with these flysch-like sediments, originated on the northeastern borders of Iraq, advancing progressively westward and southwestward through upper Campanian and Maestrichtian time (text-fig. 7).

The diachronous contact between globigerinal sediments below and clastic sediments above has been quantitatively investigated by "S/O" determinations. The results of this enquiry are illustrated in contour-map form in text-figure 8. The contour lines connect points at which the transition from globigerinal to clastic sedimentation occurred at approximately the same time, as determined from "S/O" values. This type of contouring appears to be without exact precedent in the literature. The terms "isochron" and "isochronous" are coined for the contour lines and for the map, respectively. Similar "isochronous" maps can be drawn to clarify the age relationships of the sediments underlying the post-Cretaceous break, and to elucidate the nature of the lateral passages into contemporaneous reef-type limestones, which occur in several areas within the region.

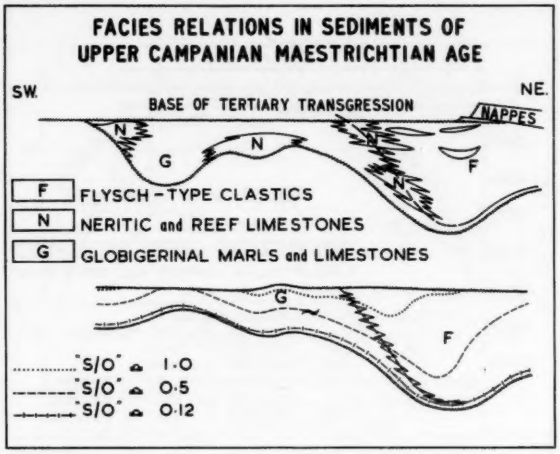
The "isochrons" are drawn at the limits of empirical time-intervals which are unequal, but the magnitude of these intervals may be visualized and roughly assessed from the "S/O-with-depth" curve of the standard section. "Isochrons" delimiting "equal" time intervals could be selected, if it could be accepted that the rate of sedimentation in the "standard section" had been constant or that it had varied progressively, in a known fashion, through Upper Cretaceous time.

There are many possible applications of age-determinations which are based on "S/O" counts and which are conveniently expressible in terms of position in a standard section, even though the actual duration of any particular "S/O" interval may be unknown. The location and evaluation of fault-omissions or fault-repetitions in well sections or in the field, and the evaluation of intraformational breaks of erosional or non-depositional origin, can all be achieved with some precision from study of continuous sample-suites. Inversion of beds can be detected from examination of only two samples. In all such applications, the omission, repetition or inversion must be of magnitude greater than the limits of determinational error for the ratios themselves, but since these limits are quite narrow, corresponding to only a few tens of feet of sediments in most areas, any major tectonic or depositional complication should be discernible.

From the gradients of "S/O-with-depth" curves for equivalent age intervals, conclusions may be drawn as to the relative rates of sedimentation in different areas or in different provinces of sedimentary facies. Similar conclusions may be drawn from variations in gradient encountered in sediments of alternating facies. This possibility is illustrated schematically in text-figure 4, where the rate of sedimentation of the silty limestone was slightly greater, and the rate of deposition of the fore-reef limestone was perhaps slightly less, than that of the "normal" globigerinal sediments.

WORLD WIDE APPLICABILITY OF THE "S/O-WITH-AGE-CURVE"

The "S/O-with-depth" curve of the "standard section" may be understood also as an "S/O-with-age" curve, subject to the limitation that equal thicknesses of sediment do not necessarily represent equal time-intervals. To obtain a quantitative "S/O-with-age" relationship, the "S/O-with-depth" curve would require adjustments depending upon rates of sedimentation throughout the sequence.

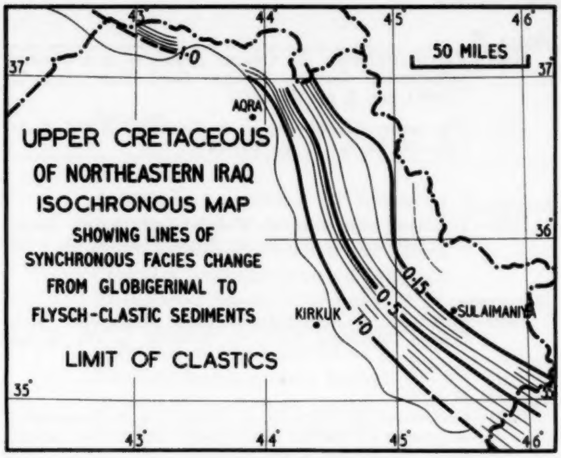


TEXT-FIGURE 7

General relations of the upper Senonian rock units. The reef-limestone complexes are very variable in position, and locally absent. The diachronism of the facies-change from globigerinal to clastic sedimentation has been investigated by "S/O" counts.

In other parts of the world, as in Iraq, unicarinate *Globotruncana* species are rare in the early upper Senonian and increase to relative dominance over multicarinate species toward the close of the Cretaceous. "S/O" values are merely a convenient numerical expression of the stage reached by the fauna in the change from multicarinate toward unicarinate assemblages. Since the end-points of this change appear to correspond, approximately, in distant parts of the world, and also to coincide, approximately, in time, it may be that generally similar and perhaps almost identical "S/O-with-age" curves may be found to apply in all areas where the Upper Cretaceous sediments are in similar globigerinal facies. It is also possible that equal "S/O" values may be universal in sediments of equal age. These possibilities may be suggested but not evaluated at present.

The need for close correlation and stratigraphic subdivision of indurated globigerinal sediments of Upper Cretaceous age is not restricted to Iraq. It may be expected that if the "S/O" method gives useful results in other regions, correlation of "S/O" values from continent to continent will be required. The establishment of isochroneity, or evaluation of age differences, for distant samples having identical "S/O" values will require comparisons of absolute ranges of recognized index fossils in terms of "S/O" time-scales. Some of the distribution data for index fossils, which are already assembled in terms of "S/O" values, are



TEXT-FIGURE 8

Isochronous map of the facies-change from globigerinal to flysch-clastic sedimentation in northern Iraq. The contours (isochrons) connect points at which the transition from globigerinal to clastic sedimentation occurred at the same times in the "S/O" time-scale.

recorded in Table 1. It must be emphasized that entries in this table are in terms of co-occurrence, and not of range. In no single case can it be asserted that the ratios shown correspond with the limits of the age-range of the fossil in question in northern Iraq. In most cases it is certain that the ranges extend far beyond the listed ratio-values. In some cases only a single value is shown, this stemming, perhaps, from a single co-occurrence.

From what is known of the geographic and stratigraphic distribution of individual *Globotruncana* species, it may be inferred that identical "S/O" values from different regions will relate to sediments of somewhat different ages. Similarly, the age significance of any "S/O" value may vary throughout any region, including northern Iraq, where the evidence indicates approximate but not yet absolute contemporaneity for samples having identical ratios. It seems probable that simple "S/O-with-age" relationships similar to those described herein will be found to apply in other regions, but that there will be some offsetting of curves along the time-axis from region to region. The "S/O-with-depth" curves for different regions and for different areas and sections within regions will have quite variable general curve-form, dependent upon rates of sedimentation, and will commence and terminate at different points in the age-depth scale, dependent upon the existence and duration of local depositional and erosional breaks.

The "S/O" values, which are related herein to depth and, by acceptance, to age, are based exclusively upon categorizations of individuals as seen in thin section. Identical results would be obtained from the study of peels or of polished surfaces. Doubtless, somewhat similar relationships would emerge from counting of separated solid forms, but exact numerical correspondence could not be expected between ratios derived from studies of solid forms and ratios based on examination of two-dimensional sections. Attempts have been made to detect a quantitative relationship between stratigraphic position and the ratios of abundance of unicarinate and multicarinate specimens in microfossil separates. Results showed a qualitative resemblance to those based on "S/O" counts, but with much greater variations around the mean. More informative results might be achieved in soft-rock areas, where complete separation of microfossils is easily achieved.

"S/O-WITH-AGE" RELATIONSHIPS IN THE CENOMANIAN—LOWER SENONIAN SECTION

It has been common knowledge for some years that, amongst the *Globotruncanidae*, single-keeled forms characterize the Cenomanian and the later Maestrichtian stages, becoming rare in the upper Turonian and lower Senonian, whilst double- and multiple-keeled forms, which are dominant in the upper Turonian and lower Senonian, are rare in the Cenomanian and late Maestrichtian (Renz, 1936; Tschachtli, 1939; Bolli, 1945, etc.). Enquiries here recorded have shown that the change from dominantly multicarinate faunas in mid-Campanian time to dominantly unicarinate faunas in late Maestrichtian time is gradual, progressive, and expressible in terms of a simple ratio, which increases systematically in value with decreasing age. Is the change from unicarinate faunas in the Cenomanian to multicarinate faunas in the lower Senonian also gradual, progressive, and expressible in terms of a simple ratio which decreases systematically in numerical value with decreasing age?

This inevitable question may be examined, but it cannot be satisfactorily answered on the basis of evidence from Iraq, where the Cretaceous succession is rather incomplete for the Cenomanian and lower Senonian stages, in areas where rocks of these ages have planktonic foraminiferal faunas. A widespread break separates mid-Turonian from mid-Cenomanian globigerinal sediments, and the lower Senonian is represented by globigerinal limestones only in a single limited area. The lack of continuous succession, and uncertainties as to the magnitude of the several breaks in the sedi-

mentary sequence, hinder enquiry into the relationship of "S/O" values to stratigraphic position. The sediments involved have not been encountered in oil wells, so that no closely spaced and finely correlated sections, linked by electric-log evidence and other independent criteria, are available to aid investigation of horizontal constancy of ratios. Such evidence as has been obtained, however, suggests that "S/O" ratios range between the same values in age-equivalent parts of correlated sections in widely separated areas. Furthermore, "S/O" values decrease from very large values to values less than unity from the bottom to the top of the represented Cenomanian. Within the represented Turonian, ratios appear to vacillate in value through the section, which is normally only 200 to 400 feet thick, but there is a perceptible overall upward diminution in "S/O".

Investigation of variation of "S/O" in the Cenomanian and lower Senonian stages has only commenced, and is unlikely to lead to any definite conclusion in Iraq. There is some considerable support for the view that "S/O" ratios are closely indicative of age in these sediments, and some suggestion that the "S/O-with-age" curve will resemble, in reverse, the curve which has been found to be applicable in the upper Campanian and Maestrichtian. Confirmation or denial of this suggestion would be possible only on the basis of intensive studies in a province where Cenomanian and lower Senonian sedimentation in globigerinal facies was essentially continuous.

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TABLE 1

SPECIES	Occurs in rocks with "S/O" value of:	Known only from rocks in which "S/O" values are: greater than:	less than:
Arenobulimina obliqua (d'Orbigny)	—	0.5	0.7
Bolivina draco Marsson	—	0.5	—
Bulimina prolixa Cushman and Parker	—	—	0.015
Cibicides beaumontianus (d'Orbigny)	0.6 ± .05	—	—
Eouvigerina gracilis Cushman	—	0.5	0.7
Globotruncana lapparenti coronata Bolli	0.22	—	—
Gyroidina naranjoensis White	—	0.5	0.9
Pseudotextularia varians Rzehak	0.11 ± .02	0.11	1.0
Stensiöina pommerana Brotzen	—	0.5	0.7
Ventilabrella eggeri Cushman	—	0.5	—
Cosinella sp., Reichel MS.	—	0.14	0.25
Cuneolina cylindrica Henson	—	—	0.25
Dictyoconella complanata Henson	—	—	0.61
Dicyclina schlumbergeri Munier-Chalmas	—	0.22	1.0
Loftusia elongata Cox	0.35	?0.31	1.25
Loftusia minor Cox	—	—	1.2
Loftusia spp.	—	0.31	—
Monolepidorbis douvillei Astre	0.22	?0.2	0.35
Omphalocyclus macropora (Lamarck)	—	0.3	2.(+?)
Orbitoides media (d'Archiac)	—	0.25	1.0
Siderolites calcitrapoides Lamarck	—	0.5	2.(+?)
Siderolites heracleae Arni	0.22	?0.10	0.31
Iranaster douvillei Gauthier	0.6	—	—
Cyclolites polymorpha Goldfuss	0.65	—	—
Cyclolites tenuiradiata de Fromentel	0.57	—	—
Irania fusiformis Hislop	—	1.5	—
Irania persica Douvillé	—	1.5	—
Janira dutemplei d'Orbigny	—	1.5	—
Paryphostoma morgani Douvillé	—	1.5	—
Nerinea pseudonobilis (Choffat)	0.65	—	—
Nucula crebilineata (Conrad)	0.07	—	—
Biradiolites royanus (d'Orbigny)	—	0.4	1.7
Hippurites morgani Douvillé	0.57	—	—
Lapeirousia jouanneti des Moulins	—	1.5	—
Orbignya cornucopiae Defrance	—	0.95	—
Orbignya persica Douvillé	—	0.65	—
Praeradiolites cylindraceus des Moulins	0.57	—	—
Praeradiolites saemanni Bayle	—	0.5	0.75
Vaccinites boehmi Douvillé	—	1.7	—
Vaccinites cf. galloprovincialis Douvillé	0.57	—	—
Rhynconella peroni Douvillé	0.79	—	—

Stratigraphic distribution of some Upper Cretaceous guide fossils in terms of "S/O" values of associated rock samples. The "S/O" ranges are very probably incomplete for all species shown.

ABSTRACT: *A revision of the type material of the forms grouped by Brady (1876) under the genus* Nodosinella *leads to an emendation of this genus and of the family Nodosinellidae. A new family, the Earlandiidae, is erected to include* Earlandia *Plummer, 1930,* Earlandinella, *n. gen.,* Earlandinita, *n. gen., and* Lugtonia, *n. gen. Lower Carboniferous representatives of the Hyperammininae and Reophacidae are also described.*

Nodosinella Brady, 1876, and associated Upper Palaeozoic genera

ROBERT H. CUMMINGS
University of Glasgow
Scotland

EDITORS' NOTE: *This is the first of a series of papers by Dr. Cummings on Upper Paleozoic smaller foraminifera and their stratigraphic significance. Subsequent papers will deal with the Tetrataxinidae, the Bradyininae, the Endothyridae, the Textulariidae (in collaboration with D. Chandra), the Ammodiscidae, and the Archaediscidae (in collaboration with R. B. Wilson). The final paper of the series will discuss the distribution of foraminiferal genera, exclusive of the Fusulinidae, in the Upper Paleozoic.*

INTRODUCTION

Prior to 1876, it was customary for any tubular or rectilinear foraminifera discovered in Palaeozoic sediments to be referred to genera and even species living at the present day. Thus Dawson (1868) referred rectilinear foraminifera found in the Acadian Carboniferous to the genus *Dentalina*.

In his monograph of 1876, Brady revised many of these earlier records and included them within his own grouping of the tubular and rectilinear foraminifera of the Upper Palaeozoic under the genus *Nodosinella*. Noting the widely divergent forms that were grouped within the confines of this genus, Brady expressed the opinion that this should be regarded as mere specific variation. Looking upon the species of *Nodosinella* as the ancestral group which gave rise to the highly varied Nodosariinae of the Mesozoic and Tertiary, he concluded that the multiplicity of form seen in the descendants was just as manifest in the ancestral stock.

Since the publication of Brady's fundamental work, other genera of tubular and rectilinear foraminifera have been noted at various horizons throughout the Palaeozoic. It would appear that these forms had a worldwide distribution from Ordovician and possibly earlier times. In addition, later workers have recorded *Nodosinella* from the Mesozoic as well as the Carboniferous and Permian, and from the Upper Palaeozoic of Europe, the United States, and Asiatic Russia.

In recent years the heterogeneous nature and original broad concept of *Nodosinella* have led to confusion in systematic identification and phylogenetic interpretation. The present revision, based on a re-examination of the type material and collections used by Brady, includes a fuller diagnosis of the genus *Nodosinella* and a new classification of the forms hitherto grouped under that name.

The author would like to acknowledge the encouragement and advice he has received throughout this work from Professor T. Neville George, Professor Alan Wood, and colleagues in the University of Glasgow, as well as the generous assistance of many American workers, including Dr. Helen Tappan Loeblich, Dr. Alfred R. Loeblich, Jr., and Dr. Brooks F. Ellis, and of the Director and officers of H. M. Geological Survey of Great Britain.

EFFECT OF SECONDARY ALTERATION

As a further result of this revision, there exists appreciable evidence to show that secondary alteration, during the diagenesis of the host sediment, has had

a marked effect on the mode of preservation of Palaeozoic foraminiferal assemblages. In particular, such alteration may lead to changes in composition and texture of the test-wall, distortion of form by leaching and crushing, and reduction in faunal content. The main processes of alteration include redistribution and recrystallisation, dolomitisation, silicification, and compaction. These may operate alone, in varying combinations, and in differing sequences.

Redistribution of slightly soluble substances in a finely disseminated condition, and of compounds in an unstable form, is evident in a great many of the British Lower Carboniferous sediments, especially calcareous deposits. The effect of this redistribution on microfaunal content is highly variable and usually, in the case of the foraminifera, is expressed by the recrystallisation of the wall-structure of the test. The mode of change is highly variable, depending on the primary condition of the test, the nature of the host sediment, and the intensity of redistribution. Thus the fibrous type of wall-structure, seen in the inner layer of *Nodosinella digitata* Brady, is prone to recrystallisation in argillaceous sediments, but in the limestone facies is usually retained in its original form. Redistribution of material in agglutinate tests, where there is a large proportion of calcareous cement, may lead to iron enrichment with or without the development of a secondary, coarser, crystalline structure in the cement.

Wood (1949) has suggested that the granular calcareous wall-structure so common in Carboniferous foraminiferal assemblages may be due to recrystallisation. There exists abundant evidence, however, to show that it represents a primary condition. The layered type of granular wall-structure, which characterises many of the Endothyrinae and the Fusulinidae, would be destroyed by recrystallisation in a manner independent of structural pattern. In the present study, numerous examples have been noted of the occurrence of members of the Earlandiidae that show the granular wall-structure both in samples containing normal members of the fibrous-walled archaediscids and in samples in which altered members of the latter group are present. Where redistribution has affected forms with a granular calcareous wall structure, it leads to the development of a relatively coarsely textured, transparent, and irregular mosaic of calcite, as seen in the outer layer of *Nodosinella digitata* (see pl. 1, fig. 14).

Of the post-depositional changes, dolomitisation seems to have the most profound effect and is undoubtedly the most widespread as an agent of destruction of the microfaunal content of Palaeozoic sediments. The dominantly morphological approach of early microfaunal research overlooked the relevance of diagenesis to assemblage patterns. Thus Brady (1876) states that "the minute structure of the Carboniferous and Permian rocks only affects the subject incidentally." The inadequacy of such a statement and the fallacy of its conceptions is proven by the present results.

The redistribution of magnesium carbonate during dolomitisation usually leads to a general recrystallisation of the rock, which may or may not be selective. In some cases the Mollusca are destroyed or partly altered, whilst the foraminifera remain in their original condition. In others the converse is true. Often the growth of dolomite rhombs is at the expense of the foraminiferal test, which may be wholly or partly replaced. In rare instances dolomitisation may lead to the replacement of original calcareous structures without destruction of form, as seen in specimens of *Reophax lawensis*, n. sp., from the type locality.

Secondary silicification occurs at many localities in the British Avonian. It exhibits a high but variable selectivity. Thus, in the Michelinia Zone of northern England, beekitisation of Brachiopoda and corals is a widespread phenomenon, but the foraminifera remain unaltered. On the other hand, at many localities in the Yoredale series of northern England and in the Lower Limestone group of Scotland, the microfaunal content has undergone complete silicification whilst the macrofauna remains unaltered or partly modified. This type of alteration frequently leads to difficulties in the recognition of the original primary condition of the test-wall (see the description of *Lugtonia*, n. gen.

The effect of compaction of the host sediment is difficult to assess in Palaeozoic foraminiferal assemblages, where collapsed or partly crushed tests are common. Distortion is much more frequent in argillaceous sediments than in limestones and hence may be due to compaction. On the other hand, whilst distortion is common in granular calcareous and agglutinated wall structures, it is displayed rarely by tests of a fibrous structure. It might therefore be assumed that it is partly due to an original flexibility of certain wall-structures and so, in turn, indicative of a primary character. The frequent difficulties of morphological analysis arising from distortion of form are exemplified by the status of *Nodosinella lingulinoides* Brady.

Essentially a revision at generic rank, this work is based almost entirely on the limited material used and described by Brady (1876). It does not include the species content of the extensive microfaunas now being recovered and examined from the British Lower Carboniferous. It is not generally realised that the greater part of Brady's material was collected in the field with brush and hand-lens, as individual specimens from the surfaces of weathered limestone and shales. When the effects of secondary alteration are recognised, it is obvious that such a collecting technique must have led to a disproportionately high percentage of altered specimens in the type collections. The wall-structure of several lectotypes is in a secondary condition, and only by reference to other material, either in the Brady collections or elsewhere, can the primary character of many genera be determined satisfactorily.

METHODS OF ANALYSIS

The recognition of widespread secondary alteration demands detailed petrological study, both of the wall-structure of the test and of the character of the host sediment, for the accurate analysis of Palaeozoic foraminiferal assemblages. Whilst surface examination and acid tests may prove adequate for the relatively unaltered assemblages of the Mesozoic and Tertiary, it is imperative that more accurate techniques be employed in the study of Palaeozoic microfaunas. The inadequacy of the dilute hydrochloric acid test so extensively used by Cushman and others is illustrated by an example from the Dockra limestone in Scotland. Apparently well-preserved specimens of *Earlandinella,* n. gen. from the silicified limestone of Law Quarry, Ayrshire, yielded an appreciable residue of very minute but distinct particles of quartz. In contrast, closely similar specimens of the same genus from the same limestone band in Lugton Quarry, where it is not silicified, yielded no residue.

In the present study, petrological analysis has been supported by various chemical techniques, including the use of Lemberg's solution as an indicator of dolomite and of potassium thiocyanate as an indicator of iron. X-ray analysis has also been introduced as a guide in the study of chamber form.

CLASSIFICATION

Morphological classification should be based as closely as possible on features arising from fundamental metabolic functions. Most modern systems of classification of the foraminifera, including those of Cushman (1948) and Glaessner (1945), recognise the structure of the test-wall as the fundamental biocharacter, and Wood (1949) has assessed its classificatory value in detail. Since the test-wall is the direct manifestation of two cytoplasmic activities, that of chemical secretion and that of the selection of adventitious material for inclusion in the fabric, it does reflect natural metabolism. The test may result from the former activity operating alone, or from both activities working together and at varying rates, or from an alternating combination of these two processes. Variety of wall-structure is therefore a direct product of differing metabolic function and mode, and hence a reliable basis of morphological classification.

Of almost equally fundamental significance is the pattern of development expressed in the chamber form of the test. The simple tube and the rectilinear, chambered form express two different types of growth which, though linked morphogenetically, must indicate widely divergent types of cytoplasmic activity.

Recognising the effect of secondary alteration in Palaeozoic assemblages, it is possible to distinguish five major classificatory units within the tubular and rectilinear foraminifera on the basis of wall-structure and chamber arrangement. Hitherto, the tubular and rectilinear smaller foraminifera of the Carboniferous have been referred to the Hyperammininae, the Reophacidae, and the Rhizamminidae.

The Rhizamminidae exhibit a simple structure consisting of a tubular chamber open at both ends, with a wall composed of arenaceous material bound by cement on an inner chitinous lining. Avnimelech (1952) and Thalmann and Bermudez (1954) have recently discussed the position of certain genera in this family, and there are indications that it may prove to be heterogeneous in character. Although representatives of the Rhizamminidae are recorded from Silurian to Recent, there are very few reliable records of their occurrence in the Upper Palaeozoic, and there appears to be no ready explanation for such an anomaly.

The Hyperammininae possess a spherical proloculum followed by a more or less straight, unsegmented tube, and have an arenaceous wall-structure. They occur in abundance in the American Pennsylvanian and are common in the Lower Carboniferous of Britain and the U.S.S.R.

The Reophacidae are characterised by a rectilinear, uniserial chambering in which the arenaceous wall is composed largely of agglutinated foreign material

Chamber arrangement	Wall-structure		
	Agglutinate	Granular calcareous	Compound
Uniserial chambers	*Reophax*	*Lugtonia* *Earlandinita*	*Nodosinella*
Incomplete septation		*Earlandinella*	
Tubular with proloculum	*Hyperammina*	*Earlandia*	*Syzrania*
Tubular, open at both ends	*Rhizammina*		

KEY TO GENERA DISCUSSED IN THIS PAPER

such as quartz grains. Plummer (1945) notes their abundance and stratigraphic value in the American Pennsylvanian, and they are now recorded in the British Lower Carboniferous.

The Earlandiidae, n. fam., include a group of forms hitherto referred to the genus *Nodosinella* Brady, which are characterised by tubular or uniserial tests in which the wall is composed of equidimensional granules of calcite bound by calcareous cement. This family is included within the superfamily Endothyridea and is analogous to the contemporaneous Hyperammininae and the Reophacidae. By far the greater number of tubular and uniserial foraminifera in the British Carboniferous are referable to the Earlandiidae.

As a result of the re-examination of the type material, the family Nodosinellidae is emended to include forms possessing a compound wall-structure of fibrous calcite and of microgranular calcite, and a tubular or uniserial chamber arrangement. It would seem that the compound wall-structure displayed by such forms is widespread in the Upper Palaeozoic and must be recognised as a distinct type.

The classification adopted herein is confined to forms that are known from the Upper Palaeozoic of Britain, the United States, and the U.S.S.R. It does not include analogous forms from post-Palaeozoic sediments.

SYSTEMATIC DESCRIPTIONS

Order FORAMINIFERA

Family **Nodosinellidae** Rhumbler, 1895, emend.

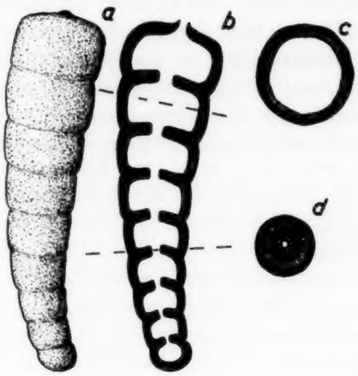
Test characterised by a uniserial arrangement of chambers and a compound wall-structure, with an inner fibrous layer.

The position of this family within the higher grouping of the foraminifera is not fully understood as yet. The unique wall-structure, which has not been observed in a completely unaltered state in *Nodosinella,* seems to indicate a position between the Endothyridea of the Upper Palaeozoic and the Lagenidea of the Mesozoic. Other genera of the Upper Carboniferous and Permian, such as *Syzrania* Reitlinger, 1950, and *Olympina* Reichel, 1945, exhibit similar compound wall-structures. It may well be that these forms are referable to a distinct group of foraminifera lacking systematic recognition at the present time.

Genus **Nodosinella** Brady, 1876, emend.

Type species: Nodosinella digitata Brady, 1876 (by later designation, Cushman, 1927).

Description (emendation from Brady): Test free, cylindrical, straight or slightly curved, composed of spherical or subglobular chambers uniserially arranged and enlarging gradually in size as added; chambers



TEXT-FIGURE 1

Nodosinella sp. Diagrams showing typical appearance. a, lateral view of complete specimen; b, longitudinal section; c-d, transverse sections. All × 25. *Note:* All diagrams of text-figures are based on photographs of specimens in the Protozoan Collection, Department of Geology, University of Glasgow.

overlapping and linked directly by circular central openings in domed septa which appear to be formed by infoldings of test-wall; sutures usually faint, thin, depressed, and absent in some cases as a result of secondary thickening; surface smooth to finely granular, with straight, curved, or faintly lobulate lateral margin; wall composed of an inner layer of fibrous calcite, finely perforate, and an outer layer of microgranular calcite, the latter usually altered to recrystallised calcite of irregular grain-size; aperture a simple, circular, terminal opening on apex of domed apertural face. In thin section, representatives of this genus may be recognised by their characteristic wall structure and chamber arrangement (see text-fig. 1).

Emendations: The present emendation is based on a detailed study of the lectotype and paratype specimens of the type species, *Nodosinella digitata* Brady, 1876, from the Permian of Tunstall Hill, Durham, England.

Chapman (1895) included in the genus forms from the Rhaetic of Wedmore, Somerset, England, which he called *Nodosinella wedmoriensis.* These forms, which are probably not foraminifera, are in no way similar to the type material of *Nodosinella* or to the Carboniferous species included by Brady (1876) in the genus (see the discussion below).

Comparison and affinities: Nodosinella differs from the tubular and rectilinear Carboniferous foraminifera, including the new genera erected below, in the possession of a characteristic wall-structure of compound plan, and a distinct chamber arrangement indicating periodic growth. It may be related to *Syzrania* Reitlinger, 1950, although that form from the Russian Carboniferous has an external fibrous layer on an inner microgranular layer, with the former often partially developed or absent.

It would seem that affinities to *Nodosinella* are to be found in contemporaneous Permian genera known from European, American, and Australasian areas, including *Geinitzina* Spandel, 1901, *Monogenerina* Spandel, 1901, *Pachyphloia* Lange, 1925, *Padangia* Lange, 1925, and *Spandelina* Cushman and Waters, 1928. *Nodosinella* exhibits a close similarity of chamber form to *Spandelina,* especially to the condition described in *Spandelina fissicostata* Cushman and Waters (1928*b*) and *Spandelina excavata* Cushman and Waters (1928*b*).

Horizon and occurrence: Nodosinella, as redefined here, is confined to the Permo-Carboniferous and Permian, and present reliable records limit its geographic distribution to European areas.

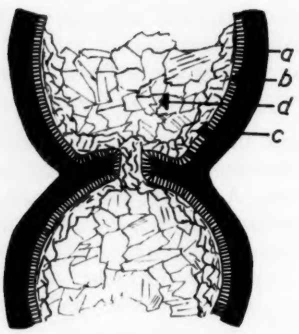
As a result of this revision, it becomes necessary to review the records of *Nodosinella* and to reassess the systematic placing of species which have previously been grouped within this genus.

A. Species referable to Nodosinella

Nodosinella digitata Brady, 1876
Plate 1, figure 14

Description: Test free, elongate, tapering, circular in cross section, straight or slightly curved, consisting of uniserially arranged inflated chambers showing a regular increase in volume from the small, spherical proloculum; chambers separated by domed septa, convex toward the apertural region and with central, circular septal opening; septa marked externally by thin, distinct, depressed sutures; lateral margin slightly lobulate, surface smooth; wall relatively thick, compound, with an inner calcareous fibrous layer and an outer layer of clear recrystallised calcite; aperture terminal, circular, central, on inflated apertural face, sometimes with slight lip.

Depository: Lectotype, Slide P.41657, and paratype (thin section), Slide P.41658, in the Brady Collection of Carboniferous and Permian Foraminifera, British Museum (Natural History), London (referred to



TEXT-FIGURE 2

Nodosinella digitata Brady. Diagram showing typical mode of preservation of test-wall. *a*, outer wall layer of transparent, irregularly recrystallised calcite; *b*, inner wall layer of yellowish fibrous calcite; *c*, layer of brownish crystalline dolomite; *d*, interior of coarsely and irregularly crystallised transparent calcite. × 150.

hereafter as B.M.N.H.), from the Middle Magnesian Limestone, Tunstall Hill, Durham, England. Both specimens from the original slide of syntypes, B.M.N.H. no. P.35489.

Dimensions of lectotype: Length of test 1.96 mm.; maximum diameter 0.66 mm.

Comparison and affinities: This species is closely similar to the forms referred by Brady (1876) to *Nodosaria radicula* (Linné), from the Upper Magnesian Limestone of the British Permian. The characteristic form and wall-structure distinguish this species from other Carboniferous species hitherto included in *Nodosinella*.

Preservation and matrix: Specimens of *Nodosinella digitata* Brady are contained in the more argillaceous facies of the Permian limestones of Durham and have all suffered secondary alteration. The detailed structure of the test-wall in material from the type locality demonstrates a pattern of fossilisation and of secondary alteration that is constant for this horizon. The style of preservation is shown diagrammatically in text-figure 2 and again in the section of the paratype (pl. 1, fig. 14). The original test is regarded as having had a compound wall-structure, with an inner fibrous calcareous layer and an outer layer that may have been composed of microgranular calcite or, less probably, of porcellanous material. The regularity of structural pattern in the layers indicates a primary condition and not one that is due to secondary alteration. Immediately after burial, or even prior to it, the layer of crystalline dolomite was deposited on the inner surfaces of the chambers. Later diagenetic activity, probably after consolidation, led to the formation of the coarsely and irregularly crystallised transparent calcite in the voids still remaining. The alteration of the outer wall-layer would result from the same or a similar diagenetic activity operating in physical and chemical conditions that did not affect the stability of the inner layer.

Horizon and occurrence: This species is relatively rare in the British Permian, and has been recorded by Liebus (1932) from the European Upper Palaeozoic. Although Brady (1876) lists this form as being present in the Yoredale series of the British Carboniferous, it has not been noted in any of the collections or areas examined. The Belgian records of Brady must also be discounted.

B. Species possibly referable to Nodosinella

Lange (1925) described the following forms from the Padanger area of Sumatra: *Nodosinella? adhaerens, N. hydrocephalus, N. minima, N. padangensis, N. perplexa, N. perpusilla*, and *N. vauseptata*. These forms are based on fragmentary thin sections in limestone, and the original descriptions lack details of the wall-structure and nature of alteration. It is possible that some may prove, on further examination, to be referable to *Nodosinella* as now emended.

Möller (1879) listed *Nodosinella lahuseni* and *N. tenuis* as new species from the Russian Carboniferous. He also recorded *Nodosinella index* (Ehrenberg), based on *Nodosaria index* Ehrenberg, 1854, and included *Nodosinella cylindrica* Brady, 1876, as a synonym of this species. Unfortunately, Möller's figures are idealized and his descriptions of wall structure inadequate. Nevertheless, his references to the perforate character of the test-wall may have arisen from a misinterpretation of an inner fibrous layer. Hence the possibility of these being true nodosinellids of Carboniferous age must be taken into consideration until the type material is re-examined.

Nodosinella clarkei, recorded by Beede (1911), is a form which also requires re-examination of the type material before it can be placed accurately.

C. Species not referable to Nodosinella

Plummer (1945) revised the taxonomy of the uniserial and tubular foraminifera of the American Pennsylvanian, and, in view of the agglutinate character of the test-wall, transferred the following species from *Nodosinella* and regrouped them under *Reophax:*

Reophax glennensis (Harlton), to include *Nodosinella ardmorensis* Harlton, 1927, *N. brevis* Waters, 1927, *N. crassa* Waters, 1927, *N. glennensis* Harlton, 1927, and *N. laheei* Waters, 1927;

Reophax arenatus (Cushman and Waters), from *Nodosinella arenata* Cushman and Waters, 1927;

Reophax fittsi (Warthin), from *Nodosinella? fittsi* Warthin, 1930.

For similar reasons the following transfer is suggested:

Reophax delicatula (Warthin), from *Nodosinella? delicatula* Warthin, 1930.

Cushman and Waters (1928*b*) showed that *Nodosinella glabra* Cushman and Waters, 1927, possessed a finely arenaceous wall-structure with a large proportion of cement and hence was more accurately placed as *Hyperamminoides glabra* (Cushman and Waters). Recently, Conkin (1954) has renamed this form *Hyperammina neoglabra,* in a revision in which *Hyperamminoides* is included as a synonym of *Hyperammina.*

The present revision leads to further amendments amongst earlier records, including:

Lugtonia concinna (Brady), from *Nodosinella concinna* Brady, 1876;

Earlandinella cylindrica (Brady), from *N. cylindrica* Brady, 1876;

Earlandinita perelegans (Plummer), from *N. perelegans* Plummer, 1930;

Earlandinita priscilla (Dawson), for the form listed by Brady (1876) as *Nodosinella priscilla* (Dawson).

D. Species of Nodosinella which must be discounted

Nodosinella lingulinoides Brady, 1876

Examination of the syntypes in the Brady Collection (B.M.N.H.) shows this species to be based on a very unsatisfactory collection of specimens. Slide P.35490, labelled Hurst, head of Swaledale [Yorkshire], contains five specimens, two of which belong to *Lugtonia concinna* (Brady), two others referable to the genus *Stacheia* Brady, 1876, and the fifth a laterally crushed biserial textulariid. The latter is the specimen described and figured by Brady (1876, pl. 7, fig. 24) as *N. lingulinoides.* Slide P.35491, labelled Castle Espie [near Comber, County Down, Ireland], contains a laterally crushed specimen of *Climacammina* Brady and is the one figured by Brady (1876, pl. 7, fig. 25) as *N. lingulinoides.* Reference to Hollick's accurate plates in Brady's original monograph is sufficient to show the biseriality of the figured material. Though the species may be included later under another genus, on the basis of these syntypes this record of *Nodosinella* must be discounted.

Nodosinella wedmoriensis Chapman, 1895

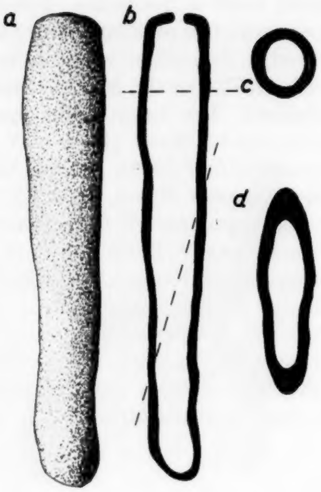
Examination of topotype material in the British Museum (Natural History) shows that Chapman's record of *Nodosinella* must also be discounted. The walls of the tests are thick and have undergone secondary mineralisation from an original agglutinate condition. Furthermore, the tests are subdivided internally by septa which lack apertural openings. This form, from the Rhaetic of Wedmore, Somerset, England, bears no resemblance to any of the Upper Palaeozoic species under consideration. It is probable that further research will show that it lies outside the foraminifera.

Superfamily ENDOTHYRIDEA Glaessner, 1945

Family **Earlandiidae** Cummings, new family

Tubular or uniserial tests in which the wall is composed of equidimensional granules of calcite bound by calcareous cement.

Although several authors, including Glaessner (1945) and Plummer (1930), have noted the similarity of wall-structure between some tubular and rectilinear foraminifera of the Upper Palaeozoic and the Endothyridea, it has been customary to refer all such forms to the Hyperammininae or to the Reophacidae. With the revision of *Nodosinella,* it becomes necessary to reassess the significance of such forms, and it is considered that there is sufficient evidence for grouping them as a distinct family within the Endothyridea. As such, they may be regarded as the Upper Palaeozoic analogues of the later Nodosariinae, and of the ubiquitous and contemporaneous Hyperammininae.



TEXT-FIGURE 3

Earlandia sp. Diagrams showing typical appearance. a, lateral view of complete specimen; b, longitudinal section; c, transverse section; d, oblique transverse section. × 50.

Genus **Earlandia** Plummer, 1930

Nodosinella (*pars*) BRADY, 1876.

Type species: Earlandia perparva Plummer, 1930.

Description: Test free, cylindrical or tapering, elongate, circular in cross section, although often laterally compressed in fossilisation, consisting of a spherical or subglobular proloculum and an elongate, tubular second chamber which shows no sign of septation; faint and irregularly spaced growth lines may show as thin constrictions on otherwise smooth outer surface; wall composed of small, equidimensional granules of calcite bound by calcareous cement, imperforate, and with smooth internal surface; broad, circular aperture at open end of tube. In thin section this genus is distinguished by the characteristic wall structure, showing dark in transmitted light, and the absence of septation (see text-fig. 3).

Comparison and affinities: Fundamental differences in wall-structure distinguish *Earlandia* and the allied *Earlandinella,* n. gen., and *Earlandinita,* n. gen., on the one hand, from representatives of both the Hyperammininae and the Reophacidae on the other.

The absence of internal septation in *Earlandia,* the partial septation of *Earlandinella,* and the more complete septation of *Earlandinita,* not only serve to distinguish one genus from another, but also indicate a morphogenetic series that appears to have some stratigraphic significance.

Preservation and matrix: Specimens of *Earlandia* from the British Lower Carboniferous are commonly unaltered, though recrystallisation and pyritisation of the test-wall is not unusual. Much of the material contained in the Brady Collection shows alteration and lateral crushing, especially toward the apertural region of the specimens.

Horizon and occurrence: Plummer (1930) first described *Earlandia* from the Pennsylvanian of Texas. Since then it has been recorded within this system in other parts of the United States. The genus has a much wider range, however, since it is found throughout the greater part of the British Lower Carboniferous, being especially common in the Upper Avonian in the argillaceous facies. Furthermore, several records of *Nodosinella* in the European Carboniferous, e.g. Liebus (1932), are erroneous and reflect the presence of species of *Earlandia.*

Earlandia pulchra Cummings, new species
Plate 1, figures 1, 15, and 21

Nodosinella cylindrica BRADY, 1876 (*pars*).

Description: Test free, moderately large, straight or slightly curved, consisting of spherical or subspherical proloculum with elongate, cylindrical or finely tapering tubular second chamber; latter showing faint, depressed, more or less regularly spaced sutures over external surface, but internally no indications of septation; smooth surface with very faint lobulation; moderately thick wall composed of equidimensional grains of calcite bound by calcareous cement; latter may be concentrated toward the exterior and hence give the appearance of a layered structure; aperture circular, terminal, simple, at end of tubiform chamber.

Depository: Holotype, Slide 11292, in the Reserve and Study Collection, H.M. Geological Survey of Great Britain, Edinburgh Office, from the Index Limestone, Upper Limestone Group, Lower Carboniferous, of Tibby's House, Muirkirk, Ayrshire, Scotland. Paratypes, Slide 11293 and Slide 11294 (thin section), in the same collection.

Dimensions: Maximum length of holotype 1.4 mm., of paratypes 0.9-1.6 mm. Maximum breadth of holotype 0.35 mm., of paratypes 0.25-0.35 mm.

Comparison and affinities: This species is somewhat larger than those recorded from the American Penn-

sylvanian by Plummer (1930), and has a more pronounced tubular habit as well as a greater regularity in sutural pattern. It is distinguished from *Earlandinella cylindrica* (Brady) by the absence of septation, as shown in X-ray photographs (pl. 1, figs. 19 and 21).

Preservation and matrix: Though unaltered tests of this species are known, it normally shows a partial recrystallisation of wall-structure and, more rarely, pyritic replacement. A thin section of a paratype specimen (pl. 1, fig. 15) illustrates the typical microstructure of the wall as an irregular mosaic of calcareous particles bound by calcareous cement and showing a decreasing grain-size toward the exterior. The wall is imperforate and has a faint brownish colour because of the presence of iron impurities in the cement. The internal matrix is composed of rather coarsely recrystallised clear calcite, with some fragments of iron oxide and localised developments of dolomite. The faint constrictions of the tube are due to crushing, and there is no indication of septation. The fragile proloculum is rarely preserved.

Horizon and facies: Earlandia pulchra appears to be confined largely to the upper part of the Lower Carboniferous. It has been recorded from the Upper Limestone Group of the Midland Valley of Scotland, where it has a common but sporadic occurrence in shaly limestones.

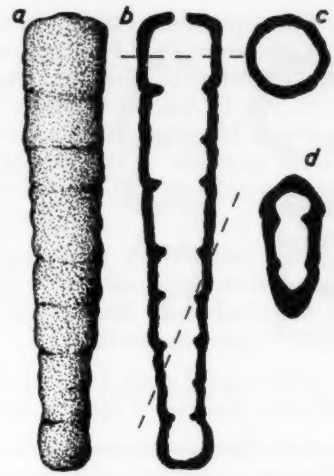
Genus **Earlandinella** Cummings, new genus

Nodosinella (pars) BRADY, 1876.

Type species: Nodosinella cylindrica Brady, 1876 (here designated).

Description: Test free, moderately large, cylindrical, circular in cross section, consisting of a spherical proloculum and slightly tapering second chamber, the latter partially and usually irregularly subdivided by incomplete septa or annular flanges produced by inward thickening of test-wall; irregularly spaced, thin, depressed sutures may correspond externally to position of internal flanges; outer surface smooth or slightly granular; wall thick, of fine-grained calcareous particles bound by calcareous cement, which is usually concentrated on the exterior producing an apparently layered structural pattern; aperture circular, terminal, at open end of tubular chamber. In thin section, specimens of *Earlandinella* are characterised by the wall-structure and the partial development of septation (see text-fig. 4).

Comparison and affinities: The relationships of this genus to other members of the Earlandiidae have been discussed above.



TEXT-FIGURE 4

Earlandinella sp. Diagrams showing typical appearance. a, lateral view of complete specimen; b, longitudinal section; c, transverse section; d, oblique transverse section. × 30.

Preservation and matrix: The British Avonian specimens are often partially recrystallised and, more rarely, silicified. Lateral crushing may result in distortion, especially toward the apertural end, where the test-wall appears to be thinner in many cases.

Horizon and facies: Earlandinella occurs in the British Lower Carboniferous as a relatively rare form. It appears to be confined to the more shaly limestones of the Upper Avonian.

Earlandinella cylindrica (Brady)
Plate 1, figures 2, 3, and 19

Nodosinella cylindrica BRADY, 1876 (*pars*).

Description: Test free, moderately large, straight or slightly curved, cylindrical or slightly tapering, circular in cross section; proloculum spherical to ellipsoidal, followed by tubular second chamber, with rather irregularly spaced, thin, depressed sutures, often indicating position of partly developed internal septa, the latter more pronounced distally and developed by inward thickening of test-wall; surface smooth or slightly granular, with some inflation between sutures; wall composed of fine-grained calcitic particles bound by calcareous cement; latter usually concentrated on the exterior to form an apparently layered structural pattern; aperture a simple, terminal, circular opening, about half the diameter of the tubular chamber, on domed apertural face.

Depository: Lectotype, Slide P.35487, in the Brady Collection of Carboniferous and Permian Foraminifera (B.M.N.H.). This slide is labelled "*Nodosinella cylindrica* Brady, p. 104, Pl. VII, fig. 7; figured specimen from Carboniferous Limestone, Elfhills, Northumberland." The other specimens on this slide of syntypes are two biserial textulariids and one indeterminable fragment.

Figured specimen, Slide 11295, in the Reserve and Study Collection, H.M. Geological Survey, Edinburgh Office, from the Charlestown Main Limestone, Wilkieston Quarry, Cupar, Fife, Scotland.

Dimensions of holotype: Length 2.75 mm.; maximum diameter 0.55 mm.; diameter of aperture 0.2 mm.

Comparison and affinities: Externally this species is closely similar to species of *Earlandia* from the British Lower Carboniferous, and is distinguished only by internal structure. The presence of partially developed septa is apparent in thin section but more easily detected by X-ray analysis in all but a few instances. Plate 1, figures 19, 21, and 22, are X-ray photographs of a specimen of *Earlandia* (fig. 21, showing absence of septation), a specimen of *Earlandinella* (fig. 19, showing partial septation), and a specimen of a Miocene nodosariid (fig. 22, showing complete septation).

Preservation and matrix: The brownish colour and honeycomb-structure of the test-wall of the holotype indicate secondary alteration by recrystallisation and iron-enrichment, the latter probably arising from a partial recrystallisation and dolomitisation of the host sediment. Usually, however, these forms are unaltered in the British Avonian, although instances of lateral crushing, leading to destruction of the apertural region, and pyritisation have been noted.

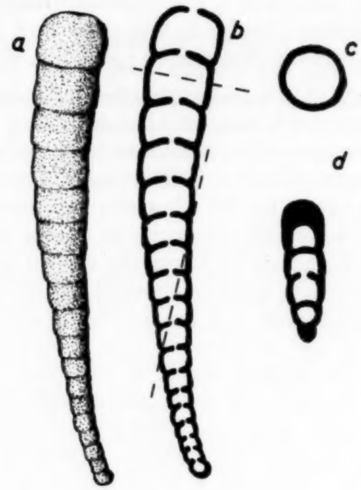
Horizon and facies: This species has been recorded at several localities in the upper part of the British Lower Carboniferous as a relatively rare form in shaly limestones. There is a noteworthy difference in size between the forms of the Lower Limestone Group and the smaller specimens from the Upper Limestone Group in Scotland.

Genus **Earlandinita** Cummings, new genus

Nodosinella (pars) Brady, 1876; Plummer, 1930.

Type species: Nodosinella perelegans Plummer, 1930 (here designated).

Description: Test free, small, straight or slightly curved, cylindrical or tapering, slender, circular in cross section, consisting of a spherical proloculum and varying number of small, cylindrical, well-defined chambers, which increase gradually in size as added; well-developed septa, with septal openings, separating chambers and marked externally by thin, distinct, depressed sutures; lateral margins slightly lobulate, surface smooth; wall composed of small, equidimensional granules of calcite bound by calcareous cement; aperture terminal, central, simple, circular, on apex of slightly domed apertural face. In thin section this genus is characterised by the wall-structure and the well-developed septation (see text-fig. 5).



TEXT-FIGURE 5

Earlandinita sp. Diagrams showing typical appearance. a, lateral view of complete specimen; b, longitudinal section; c, transverse section; d, oblique transverse section. × 90.

Comparison and affinities: Earlandinita represents the final stage in the development of septation seen in the series *Earlandia—Earlandinella—Earlandinita.*

Preservation and matrix: Although confined to shaly limestones, tests of *Earlandinita* seldom undergo secondary alteration and, as Plummer (1930) indicates, are rarely collapsed during fossilisation.

Horizon and facies: The type species was described by Plummer (1930) from the American Pennsylvanian. Representatives of this genus appear for the first time in Britain in the Upper Avonian Dibunophyllum Zone.

Earlandinita perelegans (Plummer)
Plate 1, figure 4

Nodosinella perelegans PLUMMER, 1930.

Originally described from the Pennsylvanian Brownwood shale of the United States, this species has been identified in the Dibunophyllum Zone of the British Lower Carboniferous.

Earlandinita priscilla (Dawson)
Plate 1, figures 5, 6, and 17

Dentalina priscilla DAWSON, 1868.
Nodosinella priscilla (DAWSON). – BRADY, 1876, p. 105, pl. 7, figs. 8, 9.

Description: Test free, elongate, cylindrical, straight or slightly curved, consisting of numerous distinct, slightly inflated, uniserially arranged chambers of ellipsoidal form; chambers separated externally by well-defined, depressed sutures, and internally by pronounced septa, pointed anteriorly with circular, central septal openings; lateral margin lobulate and surface smooth; wall of all topotype material has undergone secondary alteration and is now preserved as brownish recrystallised calcite of irregular texture; aperture circular, terminal, on domed apertural face.

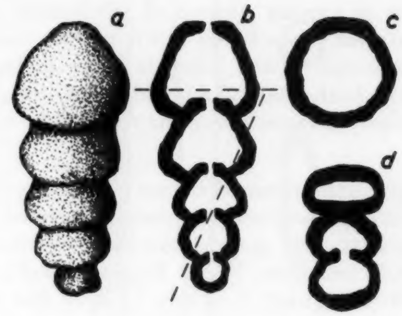
Depository: Topotype material, five specimens on Slide P.35636 in the Brady Collection of Carboniferous and Permian Foraminifera (B.M.N.H.), labelled *Nodosinella priscilla*, Carboniferous, Nova Scotia, Dawson. Also a thin section, Slide P.1100, in the Protozoa Collection, Department of Geology, University of Glasgow.

Dimensions of topotypes: Average length 2.5 mm.; average breadth 0.16 mm.

Comparison and affinities: Although the wall-structure has undergone secondary alteration, the topotype material leaves little doubt that the species should be included in the genus *Earlandinita* on the basis of chamber arrangement and septal development.

Preservation and matrix: The host sediment of the topotype material is a recrystallised, slightly dolomitised limestone containing occasional grains of quartz. The specimens are completely recrystallised and are preserved in a brownish calcite of irregular texture. Such alteration from an original microgranular texture is unusual but not unknown.

Horizon and facies: This species is as yet known from the type locality only. The Permian forms noted by Brady (1876) are distinct and are referable to *Nodosinella digitata* Brady.



TEXT-FIGURE 6

Lugtonia sp. Diagrams showing typical appearance. a, lateral view of complete specimen; b, longitudinal section; c, transverse section; d, oblique transverse section. × 45.

Genus **Lugtonia** Cummings, new genus

Nodosinella (*pars*) BRADY, 1876.

Type species: Nodosinella concinna Brady, 1876 (here designated).

Description: Test free, small, straight or slightly curved, tapering, composed of a series of globular, inflated chambers arranged in a uniserial pattern following a spherical or subspherical proloculum; chambers separated by broad, depressed, distinct sutures creating lobulate lateral margins; internal connection achieved by apertures in anteriorly projecting septa which are formed by the domed apertural faces of preceding chambers; smooth to finely granular lustrous surface; original microstructure of wall unknown, type material preserved in amorphous or crystalline silica which is of secondary origin; aperture terminal, circular, on apex of domed or conical apertural face. In thin section, species of *Lugtonia* are characterised by their chamber form and arrangement (see text-fig. 6).

Comparison and affinities: Although *Lugtonia* is closely similar to several genera of the Reophacidae, such as *Reophax* and *Hormosina*, it must be distinguished on the basis of chamber form. The present siliceous test is regarded as secondary to a granular calcareous structure, and hence *Lugtonia* is included in the Earlandiidae.

Preservation and matrix: Some 450 specimens of *Lugtonia* have been examined from seventeen scattered localities in the British Lower Carboniferous. In all specimens, the wall-structure is composed either of amorphous silica or of crystalline silica of regular

grain-size. Furthermore, at all localities there is strong evidence of varying degrees of silicification of the host sediment. Thus Brady (1876, p. 106) noted the silicified nature of the Yoredale series at the type locality in Swaledale, and referred to the original tests of the topotype material as being replaced by colloidal silica.

Although certain foraminifera are regarded as possessing a test of primary siliceous material secreted by the cytoplasm, no such genera have been recorded from Palaeozoic sediments. Whilst *Lugtonia* might be referred to this group, it is very unlikely that such a primary siliceous form should be known only from localities and environments where secondary silicification of the host sediment has occurred.

In the assemblages containing *Lugtonia*, the only other forms are secondarily silicified specimens of the Endothyridea, which possess a primary wall structure of the granular calcareous type. In view of the close similarity in the mode of preservation of the Endothyridea and *Lugtonia* from these localities, it is believed that the original wall-structure of *Lugtonia* was that of granular calcareous material bound by calcareous cement.

Horizon and facies: Lugtonia is known from the upper part of the British Lower Carboniferous and the lower Namurian, and appears to characterise that interval. It is present in the Lower Limestone Group, and common in the Upper Limestone Group, of Scotland.

Lugtonia concinna (Brady)
Plate 1, figures 9 and 20

Nodosinella concinna BRADY, 1876 (*pars*).

Description: Test free, uniserial, straight to slightly curved, translucent in clove oil, relatively broad, tapering, composed of a series of subglobular chambers; large, globular proloculum followed by two, three, or four spherical intermediate chambers and a final large, inflated, conical chamber; sutures deep, broad, well-developed; wall relatively thick, in all cases in non-calcareous secondary condition; aperture terminal, circular, at apex of conical apertural face of final chamber.

Depository: Lectotype, Slide P.35486, in the Brady Collection of Carboniferous and Permian Foraminifera (B.M.N.H.), from Swaledale, Hurst, Yorkshire, England. Figured specimen, Slide 11296, in the Reserve and Study Collection, H.M. Geological Survey of Great Britain, Edinburgh Office, from the Index Limestone, Lugton Water, near Clonbeith, Ayrshire, Scotland.

Dimensions: Maximum length of holotype 0.96 mm., of figured specimen 1.1 mm. Maximum breadth of holotype 0.37 mm., of figured specimen 0.45 mm.

Comparison and affinities: This species exhibits a wide range of form, both within populations and within sequences. When this form and the other morphological species recognised here are considered together, they seem to represent an evolving plexus.

Preservation and matrix: The preservation of the test-wall has been discussed above. Rare examples of alteration by pyritisation have been noted, and this is illustrated in the figured specimen (pl. 1, fig. 9).

This form readily succumbs to pressure, and the tests are usually found laterally compressed, deflated, and often broken into disconnected chambers. Such crushing frequently leads to distortion of the aperture, whereby it becomes triangular in outline and appears to be displaced to the side of the final chamber.

The figured specimen shows how insufficient cleaning of the host sediment from the test has led some earlier workers to list these forms as biserial textulariids.

Horizon and facies: Confined to the upper part of the British Visean and Namurian, this species is rare in the Lower Limestone Group of Scotland and very common and widespread in the Upper Limestone Group, especially in the calcareous shale facies.

Lugtonia minima Cummings, new species
Plate 1, figure 10

Description: This species differs from *L. concinna* (Brady) in its relatively small size, fewer chambers, and the rectangular chamber outline, with the breadth greatly exceeding the length in all but the last chamber.

Depository: Holotype, Slide 11297, in the Reserve and Study Collection, H.M. Geological Survey of Great Britain, Edinburgh Office, from the Index Limestone, Upper Limestone Group, Lower Carboniferous, of Lugton Water, near Clonbeith, Ayrshire, Scotland.

Dimensions of holotype: Maximum length 0.47 mm.; maximum breadth 0.3 mm.

Horizon and facies: Known only in the Scottish Visean and Namurian, this species is extremely rare in the Lower Limestone Group but common to abundant in the Upper Limestone Group.

Lugtonia inflata Cummings, new species
Plate 1, figure 11

Description: This species is characterised by the rapid increase in width leading to the pronouncedly tapering form; by the relatively large size and distinct inflation of the final chamber; and by the aperture lying in a shallow pit at the apex of the final chamber.

Depository: Holotype, Slide 11298, in the Reserve and Study Collection, H.M. Geological Survey of Great Britain, Edinburgh Office, from the Index Limestone, Upper Limestone Group, Namurian, of Lugton Water, near Clonbeith, Ayrshire, Scotland. Paratypes, Slide 11299, in the same collection.

Dimensions of holotype: Maximum length 0.75 mm.; maximum breadth 0.45 mm.

Horizon and facies: This species is a characteristic and common form in the Upper Limestone Group of the Namurian of Ayrshire and Lanarkshire, Scotland.

Lugtonia elongata Cummings, new species
Plate 1, figure 12

Description: This species differs from *L. concinna* (Brady) in its more elongate and cylindrical form, in the relatively larger number of chambers and the regularity of their volume increase, and in the larger aperture.

Depository: Holotype, Slide 11300, in the Reserve and Study Collection, H.M. Geological Survey of Great Britain, Edinburgh Office, from the upper part of the Upper Limestone Group, Namurian, of Stacklawhill, Ayrshire, Scotland.

Dimensions of holotype: Maximum length 0.92 mm.; maximum breadth 0.40 mm.

Horizon and facies: This species is common throughout the Upper Limestone Group of the Scottish Namurian.

Family HYPERAMMINIDAE

Subfamily HYPERAMMININAE

Genus **Hyperammina** Brady, 1878

Nodosinella Brady. – CUSHMAN AND WATERS, 1927 (*pars*).
Hyperamminella CUSHMAN AND WATERS, 1928. (*non* de Folin, 1881).
Hyperamminoides CUSHMAN AND WATERS, 1928.

Type species: Hyperammina elongata Brady, 1878.

Description: Test free, elongate, consisting of a spherical proloculum and long, undivided, tubular or tapering second chamber; irregularly spaced, thin, depressed transverse constrictions on exterior, with a smooth or roughened surface; wall composed of sand grains bound by varying amounts of calcareous or ferrugino-calcareous cement, and inner chitinous lining often present; terminal aperture formed by slight constriction of open end of tube. In thin section, representatives of this genus are distinguishable by their form and characteristic wall-structure (see text-fig. 7).

TEXT-FIGURE 7

Hyperammina sp. Diagrams showing typical appearance. a, lateral view of complete specimen; b, longitudinal section; c, transverse section; d, oblique transverse section. × 25.

Comparison and affinities: The agglutinate nature of the wall in *Hyperammina* distinguishes the genus from *Earlandia* of the Endothyridea, on the one hand, and from *Nodosinella,* as emended, on the other.

The relationship of *Hyperammina* Brady, 1878, and *Hyperamminoides* Cushman and Waters, 1928, is rather obscure. It has been discussed recently by Conkin (1954), who regards *Hyperamminoides* as a synonym of *Hyperammina,* and who considers the diagnostic features cited for *Hyperamminoides* by Cushman and Waters (1928*b*), the constricted aperture, siliceous test, and tapering form, as well as that noted by Plummer (1945), the rapidly expanding nature of the second chamber, to be indications of specific variation within *Hyperammina.* Examination of the type material of *Hyperammina* in the British Museum (Natural History) shows that this form has a calcareous or ferrugino-calcareous cement, whereas the wall of *Hyperamminoides* is stated to have a siliceous cement. Such a fundamental difference of secre-

tory activity in the cytoplasm cannot be regarded as mere specific variation, as Conkin would suggest. However, tests of *Hyperammina* often undergo secondary alteration by silicification in Palaeozoic sediments. This has been noted in several populations of *Hyperammina neoglabra* Conkin from different localities in the British Carboniferous. *Hyperamminoides* is therefore included within the genus *Hyperammina,* in the present work, on the grounds that the former is based on secondarily silicified specimens of the latter.

Preservation and matrix: Usually, representatives of the genus *Hyperammina* are found in the British Carboniferous in an unaltered condition. Silicified forms are readily recognisable by the overgrowths of secondary quartz on the primary adventitious quartz grains. As Plummer (1945) noted, complete specimens are rare, and fragments are difficult to distinguish from members of the Rhizamminidae. Some records of the latter group in the Upper Palaeozoic may be a result of incomplete preservation of Hyperammininae.

Horizon and facies: Originally described by Brady (1878) on the basis of Recent material, *Hyperammina* has a more or less continuous stratigraphic range from the Silurian to the present.

Hyperammina neoglabra Conkin, 1954

Nodosinella glabra CUSHMAN AND WATERS, 1927, p. 147 (*non Hyperammina glabra* Cushman and Waters, 1927, p. 146). *Hyperamminoides glabra* (Cushman and Waters). – CUSHMAN AND WATERS, 1928, and later authors.

First described from the Pennsylvanian of Texas, this species characterised by external constrictions and wall-structure is a rare form in the Upper Limestone Group of the Scottish Carboniferous.

Hyperammina clavatula (Howchin)

Hyperammina elongata Brady var. *clavatula* HOWCHIN, 1888.

This small and delicate form was described by Howchin from the upper Avonian of northern England, and has been noted in this present study as a persistent and diagnostic form in the calcareous shale facies of the upper part of the British Lower Carboniferous.

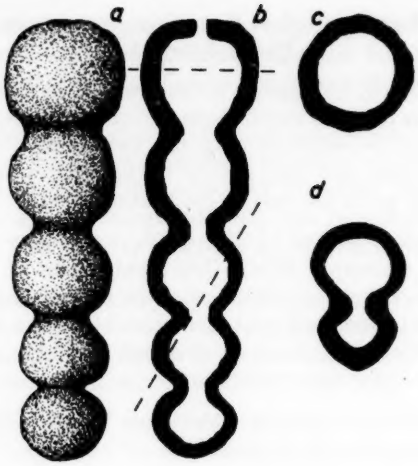
Family REOPHACIDAE

Subfamily REOPHACINAE

Genus **Reophax** Montfort, 1808

Type species: Reophax scorpiurus Montfort, 1808.

Reophax is characterised by an agglutinate test of quartz grains and other adventitious material bound



TEXT-FIGURE 8

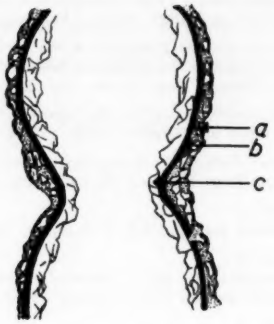
Reophax sp. Diagrams showing typical appearance. a, lateral view of complete specimen; b, longitudinal section; c, transverse section; d, oblique transverse section. × 25.

by varying proportions of cement, usually calcitic. The test is composed of globular or ellipsoidal chambers, uniserially arranged and linked by broad stoloniferous necks, whose relative length is subject to wide variation. In thin section, *Reophax* can be distinguished by the agglutinate nature of the wall and the chamber arrangement (see text-fig. 8).

Although representatives of *Reophax* have been recorded at various horizons from Cambrian to Recent, and although it is particularly common in the American Pennsylvanian (Plummer, 1930), this is the first record of its occurrence in the Lower Carboniferous and within the British Carboniferous.

Reophax lawensis Cummings, new species
Plate 1, figures 7, 13, 16 and 18

Description: Test free, large, straight to slightly curved, cylindrical, circular in cross section, composed of a number of large, spherical, inflated chambers linked by broad, circular stoloniferous necks of moderate length formed by constrictions of the tube; proloculum large and spherical; broad, depressed sutures on exterior of stoloniferous necks giving rise to lobulate lateral margins; exterior surface rough, granular; wall thick, composed of quartz grains and other adventitious material, with abundant ferrugino-calcareous cement; aperture large, circular, terminal, on apex of apertural face of last chamber.



TEXT-FIGURE 9

Diagram showing the typical mode of preservation seen in the type material of *Reophax lawensis*, n. sp. *a*, Layer I, of mixed material containing quartz grains with overgrowths, some dolomite, and secondary silica; *b*, Layer II, of lamellar-like dolomite; *c*, Layer III, chiefly of secondary silica but with some quartz grains and dolomitised fragments.

Depository: Holotype, Slide 11301, in the Reserve and Study Collection, H.M. Geological Survey of Great Britain, Edinburgh Office, from the Dockra limestone, Lower Limestone Group, Lower Carboniferous, of Law Quarry, Dalry, Ayrshire, Scotland. Paratypes, Slide 11302, in the same collection.

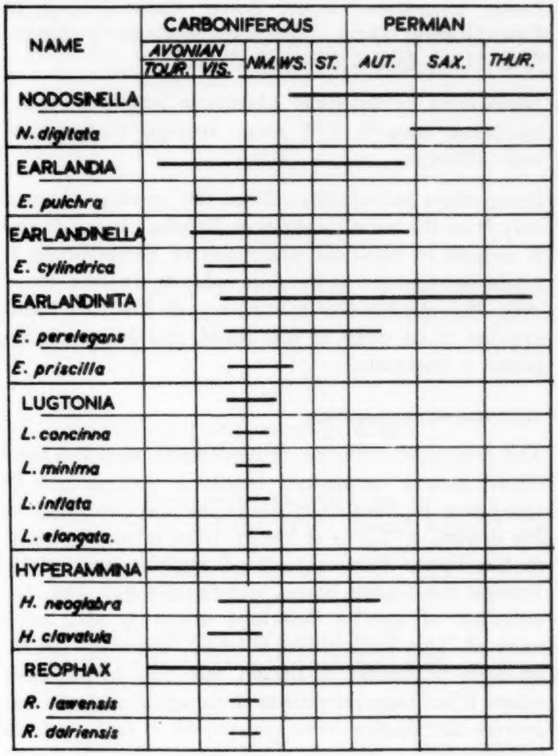
Dimensions of holotype: Maximum length 3.90 mm.; maximum breadth 1.25 mm.; average thickness of wall 0.18 mm.

Comparison and affinities: This form differs from the species of *Reophax* described from the American Pennsylvanian (Plummer, 1930) in many ways, especially in chamber form and in the proportion of cement to adventitious material in the wall.

Preservation and matrix: All specimens of *Reophax lawensis* from the type locality have undergone secondary alteration to a varying degree. The commonest mode of preservation is that seen in plate 1, figure 18, and shown diagrammatically in text-figure 9.

In this case the original agglutinate test of adventitious material, including quartz grains and an abundant ferrugino-calcareous cement, has undergone partial dolomitisation, followed by secondary silicification. This sequence of diagenetic changes can be recognised in the host sediment, with the intensity of silicification varying widely over the locality.

It would seem that Layer I represents the original agglutinate external cover, and Layer II corresponds to the chitino-calcareous inner lining often seen in the wall-structure of *Reophax*. Layer III is regarded as a partial cast of the interior produced by secondary mineralisation, which reaches its fullest expression in the numerous steinkerns of this species that are known from the type locality (pl. 1, figs. 13 and 16).



TEXT-FIGURE 10

Chart showing absolute range of forms considered herein with reference to the European time-scale.

Horizon and facies: This is a relatively rare form, being recorded from a few localities in western Scotland at the base of the Lower Limestone Group. When present, however, this species occurs in abundance.

Reophax dalriensis Cummings, new species
Plate 1, figure 8

Description: This species is distinguished from *R. lawensis* by the relatively smaller chambers, the shorter stoloniferous necks, and the thinner wall.

Depository: Holotype, Slide 11303, in the Reserve and Study Collection, H.M. Geological Survey of Great Britain, Edinburgh Office, from the Dockra limestone, Lower Limestone Group, Lower Carboniferous, of Law Quarry, Dalry, Ayrshire, Scotland. Paratype, Slide 11304, in the same collection.

Dimensions of holotype: Maximum length 5.8 mm.; maximum breadth 0.85 mm.; average thickness of wall 0.10 mm.

Comparison and affinities: Since this species is known only from the same localities as *Reophax lawensis* and is subject to identical conditions of preservation, it might be regarded as the dimorphic equivalent. However, the quantitative occurrence of the two forms appears to be more or less equal, and hence dimorphism is discounted.

STRATIGRAPHIC DISTRIBUTION

The general distribution of *Nodosinella* and the associated genera considered herein is summarised in text-figure 10. This chart shows the absolute range of the genera, so far as is known from present records, in the Upper Palaeozoic of all regions, particularly Europe, the United States, and the U.S.S.R. The distribution of species described above is also summarised. This information is based, however, largely on their occurrence in Britain, and only in instances where it has been possible to study actual material has species distribution been considered in areas outside of Britain.

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EXPLANATION OF PLATE 1

1 *Earlandia pulchra* Cummings, n. sp.
Holotype, lateral view. × 15.

2 *Earlandinella cylindrica* (Brady)
Lectotype, lateral view. × 34.

3 *Earlandinella cylindrica* (Brady)
Figured specimen, lateral view. × 43.

4 *Earlandinita perelegans* (Plummer)
Figured specimen, lateral view. × 34.

5 *Earlandinita priscilla* (Dawson)
Excavated incomplete specimen, lateral view. × 30.

6 *Earlandinita priscilla* (Dawson)
Apertural end of incomplete specimen, lateral view. × 26.

7 *Reophax lawensis* Cummings, n. sp.
Holotype, lateral view. × 18.

8 *Reophax dalriensis* Cummings, n. sp.
Holotype, lateral view. × 13.

9 *Lugtonia concinna* (Brady)
Figured specimen, lateral view. × 52.

10 *Lugtonia minima* Cummings, n. sp.
Holotype, lateral view. × 47.

11 *Lugtonia inflata* Cummings, n. sp.
Holotype, lateral view. × 46.

12 *Lugtonia elongata* Cummings, n. sp.
Holotype, lateral view. × 45.

13 *Reophax lawensis* Cummings, n. sp.
Steinkern in colloidal silica, lateral view. × 13.

14 *Nodosinella digitata* Brady
Paratype, thin section, lateral view. × 41.

15 *Earlandia pulchra* Cummings, n. sp.
Paratype, thin section, lateral view. × 60.

16 *Reophax lawensis* Cummings, n. sp.
Steinkern in amorphous silica, thin section, lateral view. × 26.

17 *Earlandinita priscilla* (Dawson)
Topotype, thin section, lateral view. × 78.

18 *Reophax lawensis* Cummings, n. sp.
Paratype, thin section, lateral view of wall only. × 30.

19 *Earlandinella cylindrica* (Brady)
Lectotype, X-ray photograph, lateral view. × 18.

20 *Lugtonia concinna* (Brady)
Thin section, lateral view. × 34.

21 *Earlandia pulchra* Cummings, n. sp.
Figured specimen, X-ray photograph, lateral view. × 18.

22 Miocene nodosariid
X-ray photograph, lateral view. × 18.


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ABSTRACT: *The hingement of* Beyrichia jonesii *is described. The morphology in relation to classification, and the classification, distribution, and phylogeny of the Beyrichiidae are discussed.*

A short account of the ostracod family Beyrichiidae

GUNNAR HENNINGSMOEN
Paleontological Museum
University of Oslo

INTRODUCTION

The ostracod family Beyrichiidae was the first family of straight-hinged Paleozoic ostracods to be established. The family has undergone numerous revisions, as a result of which the superfamily Beyrichiacea now more or less corresponds to the family Beyrichiidae of earlier authors. This short account may serve as an aid in understanding the family.

In the classic paper on the Silurian of Maryland, Ulrich and Bassler (1923) demonstrated that ostracods can be useful in biostratigraphic classification and correlation. A critical revision of the stratigraphic and geographic distribution of the beyrichiid genera is given here for the benefit of stratigraphers.

TERMINOLOGY

The terminology is that suggested by Hessland (1949) and Kesling (1951), with some amendments proposed by Henningsmoen (1953, 1954). Some of the terms are explained in text-figures 1 and 4.

OVERLAP AND HINGEMENT

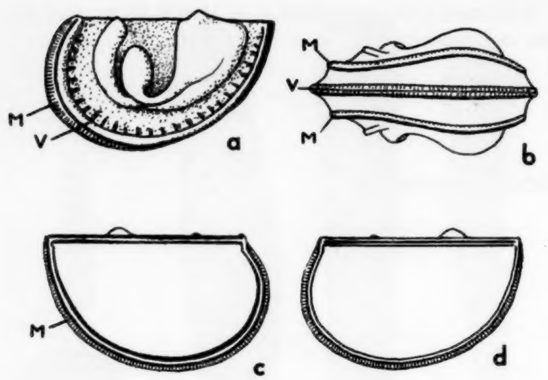
The overlap and hingement are often neglected in the description of beyrichiids, partly because an examination of these features requires well-preserved material, either freed of matrix or studied in thin section, and partly because due attention has not been paid to these features. From what is known, the overlap is generally very small in the beyrichiids, with the exception of the genus *Kyammodes*. Kesling (1953*a*) has shown that the right valve overlaps the left in *Phlyctiscapha rockportensis* Kesling, 1953. The reverse appears to be more common; thus, the left valve overlaps the right in *Hibbardia lacrimosa* (Swartz and Oriel, 1948) (see Kesling, 1953*b*), *Kyammodes, Craspedobolbina dorsoplicata* Henningsmoen, 1954, and in *Beyrichia jonesii* Boll.

The hingement of beyrichiids has rarely been described. According to Levinson (1950, p. 66), the hingement of *Beyrichia fittsi* Roth, 1929, consists of a straight hinge groove running the entire length of the dorsal margin of the right valve, and a corresponding hinge ridge in the left valve. *Beyrichia (Nodibeyrichia) tuberculata* (Klöden, 1834) and *B. (Velibeyrichia) waldronensis* Ulrich and Bassler, 1908, were stated to have the same type of hingement.

Some valves of *Beyrichia (Mitrobeyrichia) jonesii* Boll, 1856, from well-preserved material statistically studied by Spjeldnaes (1951), show very well the hingement and other marginal features (text-fig. 1). The hingement agrees with that in *B. fittsi*. Furthermore, it is seen that the contact margin of the free borders of the right valve has a narrow ridge along its inner side. This is overlapped by a similar narrow ridge along the middle part of the contact margin of the left valve. A cross section of this species was illustrated by Swartz (1936, pl. 78, fig. 8d, and pl. 84, fig. 3h). *Beyrichia clavata* Kolmodin, 1869, was regarded as a synonym of *B. jonesii* by Spjeldnaes (1951).

MORPHOLOGY AND CLASSIFICATION

Classification of the Beyrichiidae is based on morphological features of the valves, such as type of lobation, type of pouch, and type of velate structure. Unusual



TEXT-FIGURE 1

Beyrichia (Mitrobeyrichia) jonesii Boll, showing marginal frill *(M)*, velate frill *(V)*, and contact margins. a, lateral view of exterior of left valve; b, ventral view of entire carapace with anterior end to the left; c-d, views of contact margins on inner side of left valve (c) and right valve (d).

features, such as the double pouch in *Zygobolbina* and the whiplash-like ridge of *Mastigobolbina*, are often very useful in tracing relationships. On the other hand, it is usually dangerous to base the classification on a single feature, since similar features may appear in different trends. As discussed earlier (Henningsmoen, 1953), "smooth" ostracods may be more closely related to forms with stronger relief than to other, more similar-looking smooth forms. It appears that any phylogenetic stage of beyrichiacean ostracods may produce smooth forms, forms with strong relief, or intermediate forms. This does not mean that a phylogenetic lineage may not produce, for example, only smooth forms, at least for some time, but one should not be surprised if forms with strong relief eventually develop in the same lineage. One may visualize this situation by imagining the phylogenetic lineage as a line proceeding in a field bounded on one side by a line representing extremely smooth forms, and on the other side by a line representing forms with extremely strong relief. The phylogenetic line would sometimes be closer to one side, and at other times nearer to the other, or more or less in the middle, and at times also branching. The different number of sulci is only an example of the variation between smooth forms and forms with strong relief. Consequently, it is not surprising that the number may vary in closely related species, and that forms with fewer sulci may develop from forms with more sulci or vice versa. For example, *Plethobolbina*, with one sulcus, developed from *Mastigobolbina* with two sulci, whereas *Mastigobolbina bifida*, with three sulci, developed out of earlier species of *Mastigobolbina* with two sulci.

The type of velate structure, such as a smooth ridge, a spinose ridge, or a frill, may be rather constant in some groups, but may also vary in closely related species, and may even be different in the dimorphs of a given species. It may be recalled here that the length/height ratio seems to vary considerably within some species of beyrichiids (see Henningsmoen, 1954, p. 42), and that it is possible that some extremely short or extremely long specimens of one species have sometimes been referred to different species.

CLASSIFICATION

The family Beyrichiidae was formerly considered in a rather wide sense. Swartz (1936), in a revision of the Primitiidae and Beyrichiidae, erected the families Hollinidae and Tetradellidae for some genera which were excluded from the Beyrichiidae. On the other hand, he included in this family the members of the subfamily Eurychilininae, which had been erected by Ulrich and Bassler (1923) as a subfamily of the Primitiidae. Hessland (1949, pp. 123-128) stressed the important difference between the extraneous "false" pouch of the Eurychilininae, formed by the velate frill, and the true pouch of the Beyrichiidae, which opens into the main cavity of the valve. Henningsmoen (1953, p. 235) redefined the Beyrichiidae to include all forms with a true pouch, and only those forms. Consequently, the family Zygobolbidae Ulrich and Bassler, 1923, was regarded as a synonym of the Beyrichiidae, whereas the subfamily Eurychilininae was excluded from the Beyrichiidae. Ulrich and Bassler (1923) divided the family Zygobolbidae into three subfamilies: Zygobolbinae, Kloedeniinae, and Drepanellinae. The Zygobolbinae were retained as a subfamily of the Beyrichiidae by Henningsmoen, but two genera, *Mastigobolbina* and *Plethobolbina*, were transferred into it from the Kloedeniinae. *Steusloffia* Ulrich and Bassler, 1908, has no pouch, and was excluded from the Kloedeniinae, whereas *Drepanellina* was regarded as a kloedeniid and removed from the Drepanellinae. *Drepanella* Ulrich, 1890, and the other remaining genera in the Drepanellinae have no pouch, and this group was regarded as constituting a separate family. The subfamily Kloedeniinae was regarded as a synonym of the Beyrichiinae, but was revived as a separate subfamily of the Beyrichiidae by Henningsmoen (1954), who, moreover, erected a new beyrichiid subfamily, the Treposellinae. The classification presented below is the one adopted by Henningsmoen in 1954.

Order OSTRACODA Latreille, 1802

Suborder PALEOCOPA Henningsmoen, 1953

Superfamily BEYRICHIACEA Ulrich and Bassler, 1923

Family **Beyrichiidae** Jones, 1894

Diagnosis: Dimorphic straight-hinged ostracods in which one of the dimorphs of each species has a pair of pouches, one in each valve, situated anteriorly to posteroventrally. The pouches open into the main cavity of the carapace. Non- to trisulcate. S1 more persistent than S2. Velate structure usually present as a ridge or frill.

Subfamilies: Beyrichiinae, Zygobolbinae, Kloedeniinae, and Treposellinae.

Subfamily **Beyrichiinae** Jones, 1894

Diagnosis: Beyrichiidae with pouch more or less anteroventrally situated. S1, when present, shorter than S2. Zygal ridge usually lacking; when present, its posterior branch does not reach the dorsal border. Velate structure developed as a tuberculate, spinose, or smooth ridge, or as a frill, or may exceptionally not be developed at all. Surface tuberculate, spinose, or smooth.

Genera: Beyrichia McCoy, 1846 (with six subgenera: *Beyrichia* McCoy, 1846, and five other subgenera erected by Henningsmoen, 1954, namely, *Eobeyrichia, Mitrobeyrichia, Neobeyrichia, Nodibeyrichia,* and *Velibeyrichia*); *Craspedobolbina* Kummerow, 1924; and, tentatively, *Apatobolbina* Ulrich and Bassler, 1923, *Bolbibollia* Ulrich and Bassler, 1923, and *Dibolbina* Ulrich and Bassler, 1923.

Subfamily **Zygobolbinae** Ulrich and Bassler, 1923

Diagnosis: Beyrichiidae with anteriorly to anteroventrally situated pouch. Uni- to trisulcate. S1, when present, longer than S2. Zygal ridge usually present; its posterior branch reaches the dorsal border. Velate structure a smooth ridge or a narrow smooth frill. Surface smooth, pitted, or, rarely, granulate.

Genera: Bonnemaia, Mastigobolbina, Plethobolbina, Zygobolba, Zygobolbina, and *Zygosella,* all erected by Ulrich and Bassler, 1923.

Subfamily **Kloedeniinae** Ulrich and Bassler, 1923

Diagnosis: Beyrichiidae with more or less anteroventrally situated pouch. Only bi- and trisulcate forms are known, but S1 may be very faint in some bisulcate species. Velate structure always a smooth ridge. Surface usually smooth, but may be pitted.

Genera: Cornikloedenia Henningsmoen, 1954, *Drepanellina* Ulrich and Bassler, 1923, *Kloedenia* Jones and Holl, 1886, *Kyammodes* Jones, 1888, *Welleria* Ulrich and Bassler, 1923, and *Zygobeyrichia* Ulrich, 1916.

Subfamily **Treposellinae** Henningsmoen, 1954

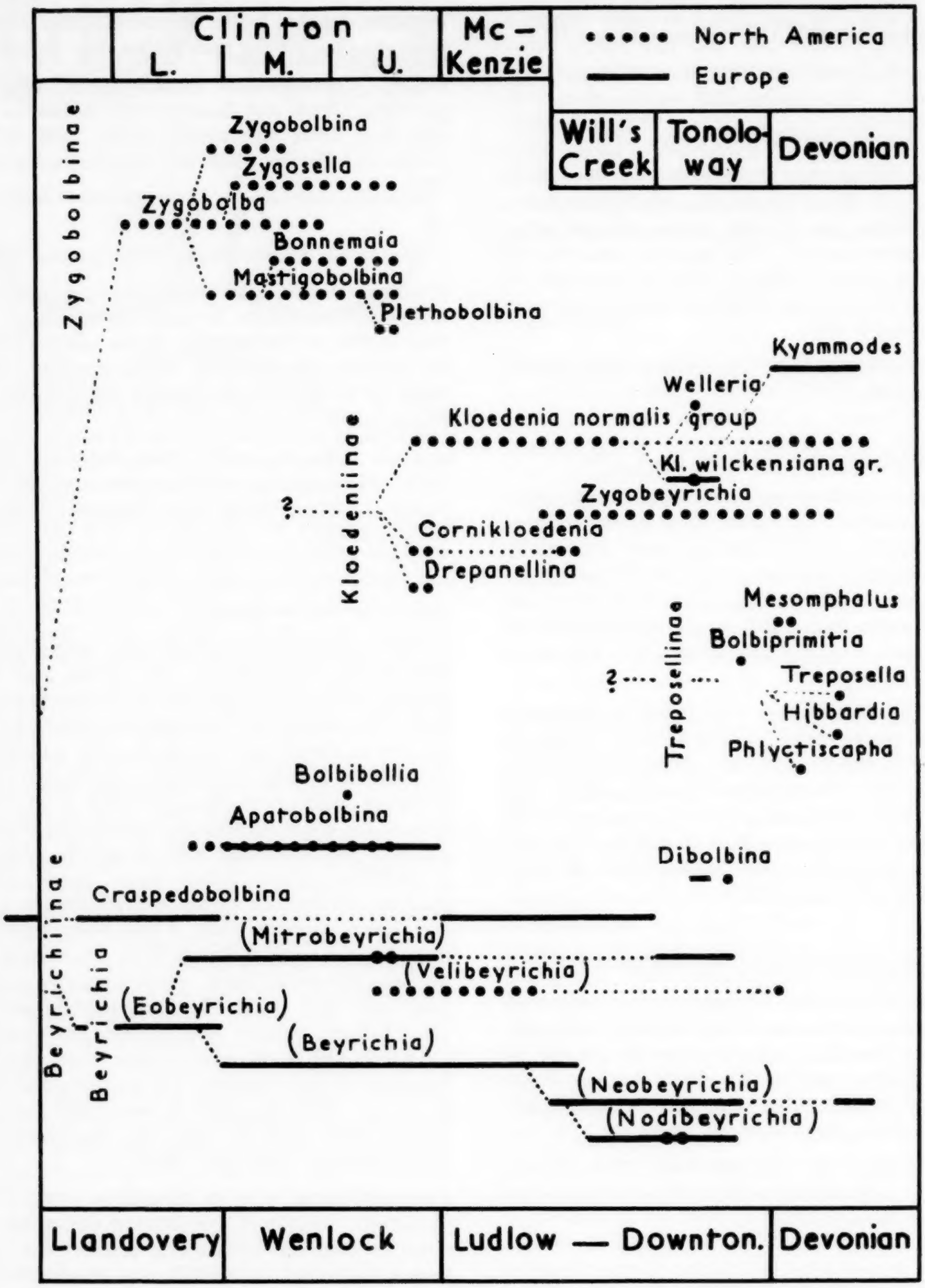
Diagnosis: Beyrichiidae with ventrally to posteroventrally situated pouch, in some cases almost indistinguishable on the exterior of the valve. Only unito nonsulcate species known. Velate structure a smooth ridge or a narrow frill. Surface smooth, pitted, or reticulate.

Genera: Bolbiprimitia Kay, 1940, *Hibbardia* Kesling, 1953*b*, *Mesomphalus* Ulrich and Bassler, 1923, *Phlyctiscapha* Kesling, 1953*a*, and *Treposella* Ulrich and Bassler, 1913.

DISTRIBUTION AND PHYLOGENY

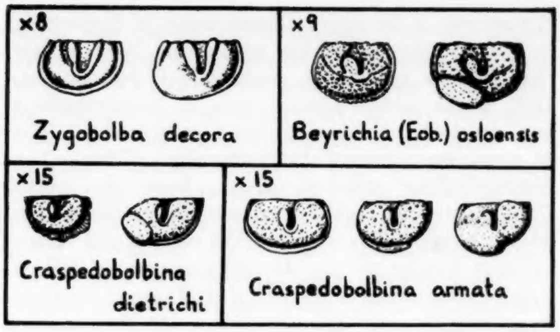
A chart (text-fig. 2) illustrates the vertical distribution of the beyrichiids as now known, and distinguishes between European and North American members. The ranges of the European members should be plotted against the European scale, and those of the North American members against the North American scale, since the correlation is as yet uncertain. No doubt additional knowledge of the occurrence of the beyrichiids will change the chart, but it probably already reflects main trends and the principal distribution of the Beyrichiidae in Europe and North America. Only a few unequivocal beyrichiids have been described from other areas, such as *Beyrichia epona* Öpik, which occurs in Australia (see Öpik, 1953, p. 33). The finely dotted lines in the chart indicate possible relationships, but should not be interpreted as showing exactly when one group branched off from another. Many genera and species that were earlier regarded as beyrichiids have more recently been excluded from the Beyrichiidae (see Henningsmoen, 1953 and 1954).

Craspedobolbina dietrichi Kummerow, 1924, from a glacial drift boulder of probably late Ordovician limestone in northern Germany, is possibly the earliest known beyrichiid. It reminds one of primitiids and eurychilinids, from which the Beyrichiidae may have developed, but it also reminds one of *Beyrichia (Eobeyrichia)* and the Zygobolbinae, with which it



TEXT-FIGURE 2

STRATIGRAPHIC RANGES OF NORTH AMERICAN AND EUROPEAN BEYRICHIIDAE



TEXT-FIGURE 3

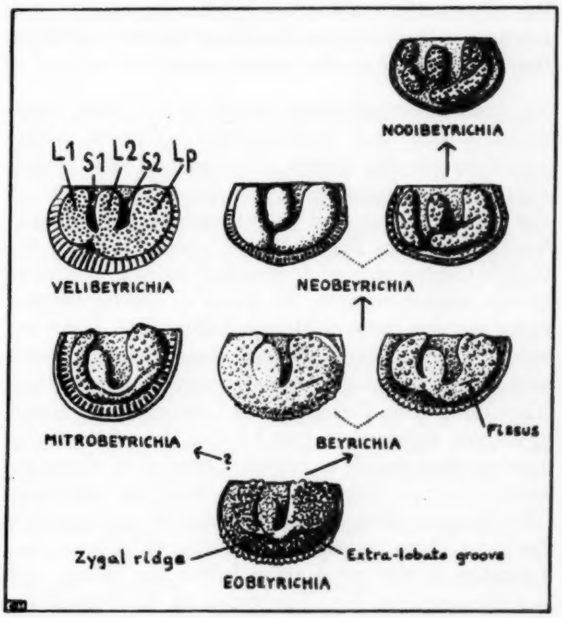
Pouchless and pouch-bearing left valves of some early beyrichiids. *Zygobolba decora* after Ulrich and Bassler (1923, pl. 64, fig. 24); *Craspedobolbina dietrichi* after Kummerow (1924, pl. 20, figs. 27-28); the others drawn from actual specimens (see Henningsmoen, 1954).

shares a zygal ridge (text-fig. 3). All material of this species is lost, according to a personal communication from Dr. E. Kummerow, but it is to be hoped that specimens of this species may eventually be discovered in situ somewhere in the Scando-Baltic area.

The earliest known members of the Beyrichiinae whose stratigraphic position is certain are *Craspedobolbina armata* Henningsmoen, 1954, and *Beyrichia (Eobeyrichia) paucituberculata* Henningsmoen, 1954, both from the middle part of the lower Llandovery in the Oslo region, Norway. *Craspedobolbina armata* may be close to *C. dietrichi*, but differs in having a pouch which is less well defined from the exterior of the valve. Pouch-bearing valves of *C. armata* have a velate ridge, and this seems to be the case in *C. dietrichi* as well. Pouchless valves of *C. dietrichi* have a rather wide, entire and striate frill, whereas the frill is rather narrow and rather smooth in *C. armata*. Furthermore, it is entire only in larger pouchless valves, whereas it is restricted in the smaller valves. However, *C. dietrichi* is not very well known, and it is possible that more material would show that this form was trimorphic also. Even if it was not trimorphic, the differences between *C. dietrichi* and *C. armata* do not negate a rather close relationship between the two species.

Species assigned to *Craspedobolbina* occur in both the Llandoverian and the Silurian in the Oslo region. They are no doubt related to *C. armata*. Some of the later species are more tumid and smoother than *C. armata* and *C. dietrichi*, and as a result their pouch and L2 are less well defined, and the sulcus less prominent. In the very smooth species *C. primitiva* (Verworn, 1887), the sulcus is rather shallow and diffuse in the pouchless valves, the pouch is almost confluent with the rest of the valve exteriorly, and the velate structure apparently is not developed.

Beyrichia itself has been split into several subgenera (text-fig. 4). A zygal ridge is present in the earliest known subgenus, *Eobeyrichia*, from the Llandoverian, thus suggesting relationship with *Craspedobolbina dietrichi* and *Zygobolba*. The ridge is retained also in the subgenus *Mitrobeyrichia*, which appears somewhat later than *Eobeyrichia*, and which is characterized by a girdle-like frill, whereas the velate structure in *Eobeyrichia* is present as a spinose ridge. There is a regular transition from *Eobeyrichia* to the subgenus *Beyrichia*, which has no distinct zygal ridge and in which the extralobate groove of *Eobeyrichia* is reduced to an isolated groove, the fissus. In one trend of the genus *Beyrichia* there is a tendency of the lobes to become isolated from each other, and to be split into two or more smaller nodes. Thus *Neobeyrichia*, which developed from the subgenus *Beyrichia*, has an isolated L1; and L2 and Lp may or may not be united. In *Nodibeyrichia*, which appears slightly later, L2 is always isolated, L1 is split into two nodes, and Lp may also be split into two or more nodes.



TEXT-FIGURE 4

Subgenera of *Beyrichia*. Possible relationships are indicated. All figures of left valves. After Henningsmoen (1954, text-fig. 2), except that some terms have been added.

The relationship of the subgenus *Velibeyrichia* to the other subgenera of *Beyrichia* is uncertain. It resembles the subgenus *Beyrichia* in the type of lobation, but has a wide striate frill, and seems never to have a fissus, a feature so common in the subgenus *Beyrichia* and its derivatives.

Whereas *Craspedobolbina* is known only in Europe, *Beyrichia* is known also in North America. However, there is a greater variety of forms of *Beyrichia* in Europe, where, furthermore, the genus seems to have appeared earlier.

The subfamily Zygobolbinae is another group of beyrichiids confined to North America. The earliest members, species of *Zygobolba* from the base of the lower Clinton, have the zygal ridge as well as the pouch in common with early members of *Craspedobolbina* and *Beyrichia,* and it seems reasonable to assume that they are all related. Especially characteristic of *Zygobolba* is its U-shaped, narrow zygal ridge, whose posterior branch reaches the dorsal border. *Zygobolbina,* which appears at the top of the lower Clinton and which apparently developed from *Zygobolba,* is unique in having the pouch split into two parts in each valve. *Zygosella,* appearing in the middle Clinton, represents another trend from *Zygobolba,* and has an anteriorly situated pouch developed as a ridge-like lobe parallel to the anterior margin.

No doubt *Mastigobolbina* also developed from *Zygobolba.* Ulrich and Bassler (1923) divided *Mastigobolbina* into five groups. The group of *Mastigobolbina incipiens,* from the top of the lower Clinton, is the earliest group and might perhaps better have been included in *Zygobolba.* Somewhat later, in the middle Clinton zone of *Mastigobolbina lata,* two other groups appear, namely, the group of *Mastigobolbina typus* and the group of *Mastigobolbina lata.* There are several species which are transitional between them, and the groups are apparently very closely related. They differ from *Zygobolba* and the group of *Mastigobolbina incipiens* in that L2 and the whole of Lp (rather than merely a posterior branch of the zygal ridge) form a U-shaped, rather dominant elevation. The *M. typus* group differs from the *M. lata* group in having a characteristic whiplash-like ridge as a continuation of the zygal ridge below the sulcus, and superimposed on Lp. The group of *Mastigobolbina bifida,* in the upper Clinton zone of *Bonnemaia rudis,* no doubt developed from the earlier forms of *Mastigobolbina. Mastigobolbina bifida* Ulrich and Bassler, 1923, is very interesting, as it is one of the few known examples of a trisulcate species having developed from bisulcate ancestors. *Bonnemaia,* in the upper Clinton zones of *Bonnemaia rudis* and *Mastigobolbina typus,* and with a less characteristic species, *B. notha* Ulrich and Bassler, 1923, in the middle Clinton zone of *Mastigobolbina lata,* no doubt developed from *Mastigobolbina.* The *M. typus* group occurs also in the upper Clinton. The *Mastigobolbina trilobata* group, from the upper Clinton, may be regarded as smooth species of the *M. typus* group. The whiplash-like ridge is still visible in most species of the *M. trilobata* group, but is usually fainter than in the group of *M. typus.* Furthermore, S1 is very narrow, almost slit-like, in the *M. trilobata* group.

Even smoother species are represented by the typical members of *Plethobolbina,* which no doubt developed from the *Mastigobolbina typus* group by way of the *Mastigobolbina trilobata* group. In *Plethobolbina,* which is one of the many examples of a unisulcate group that developed from bisulcate ancestors, S1 is either very faintly indicated or absent. Remnants of the whiplash-like ridge are still present in *Plethobolbina typicalis* Ulrich and Bassler, 1923, which is fortunate, since smooth species of different trends tend to resemble each other and often have lost the features that characterize the related species with better relief. This fact makes it difficult to say with certainty from which group the smooth forms have developed. Two earlier species that have been assigned to *Plethobolbina,* namely, *P. cribraria* Ulrich and Bassler, 1923, from an unspecified zone of the lower Clinton, and *P. sulcata* Ulrich and Bassler, 1923, from the middle Clinton zone of *Zygobolbina emaciata,* can hardly be congeneric with the typical *Plethobolbina* species. They were both established on rather poor material, but seem to be of the *Plethobolbina* type, rather smooth and unisulcate. However, this type may have developed among earlier zygobolbids as well. For example, *Mastigobolbina incipiens* Ulrich and Bassler, 1923, tends toward this type. If *Plethobolbina* is to be regarded as a monophyletic genus, *P. cribraria* and *P. sulcata* should be removed from it. Their rather poor preservation makes it difficult to suggest their nearest relatives.

The subfamily Zygobolbinae is thus a rather compact group of closely related genera. *Zygobolba* gave rise to *Zygobolbina, Zygosella,* and *Mastigobolbina,* and the latter genus in turn gave rise to *Bonnemaia* and *Plethobolbina.*

The subfamily Kloedeniinae as redefined by Henningsmoen (1954, p. 29) may consist of closely related

forms. The earliest known species, from the upper Clinton, belong to *Drepanellina, Cornikloedenia,* and the group of *Kloedenia normalis. Zygobeyrichia,* which first appears in the upper part of the McKenzie formation, may have developed either from the *Kloedenia normalis* group or from *Cornikloedenia. Welleria,* confined to the Wills Creek formation, apparently developed from the *Kloedenia normalis* group. *Kloedenia wilckensiana* (Jones, 1855), the type species of *Kloedenia,* may likewise have developed from this group. It occurs in the Downtonian in Europe, as does a possibly related species, *Kloedenia kiesowi* Krause, 1891. *Kyammodes whidbornei* Jones, 1888, the type species of *Kyammodes,* occurs in the Devonian in England. Several species that have been assigned to *Kyammodes* are apparently not closely related to the type species, which is characterized by a very small L2 and a rather great overlap. For example, *Kyammodes tricornis* Ulrich and Bassler, 1923, may belong to the *Kloedenia normalis* group, and *Kyammodes swartzi* Ulrich and Bassler, 1923, may be close to *Kloedenia kiesowi,* which should not be assigned to *Kyammodes.*

The origin of the subfamily Kloedeniinae is not certain. Apparently it developed either from the Zygobolbinae or the Beyrichiinae. Ulrich and Bassler (1923) regarded the Kloedeniinae as a subfamily of the Zygobolbidae, but they included zygobolbid genera in this subfamily also. Henningsmoen (1954, p. 29) regarded the subfamily Kloedeniinae as being closer to the Beyrichiinae than to the Zygobolbinae, mainly because of the lack of a zygal ridge and the great resemblance between *Beyrichia* and *Kloedenia.* The subfamily Kloedeniinae is considered in the same sense here as in 1954, but I would like to add that there are some indications that it developed from the Zygobolbinae. Firstly, it apparently appears earlier in North America than in Europe; only some later members, namely, the group of *Kloedenia wilckensiana* and the genus *Kyammodes,* which is apparently confined to Europe, are known with certainty in Europe. Furthermore, the usually rather prominent L2, the smooth velate ridge, and the rather badly defined pouch are features which, on the whole, agree better with the Zygobolbinae than with the Beyrichiinae. Öpik (1953, p. 35) described from Australia a Silurian species which he called *Drepanellina victoriana.* However, no pouch-bearing specimens were found, and consequently it is uncertain whether it is a beyrichiid.

The subfamily Treposellinae constitutes another North American group of beyrichiids. Its members all have a more or less ventrally situated pouch, and all appear rather late, Tonoloway to Devonian. The origin of the subfamily is uncertain. It reminds one somewhat of late species assigned to *Craspedobolbina,* but the resemblance may be due to convergence.

The origin of the three genera *Apatobolbina, Bolbibollia,* and *Dibolbina* is also uncertain. Because of their well-defined pouch they are tentatively assigned to the Beyrichiinae. *Apatobolbina* and *Dibolbina* agree with some members of this subfamily also in having a well-developed frill.

In considering the evolution of the Beyrichiidae as a whole, it is interesting to observe that in most phylogenetic lineages the beyrichiid pouch, a new feature among the beyrichiacean ostracods, becomes more and more incorporated with the rest of the valve. In some forms, such as *Phlyctiscapha,* it can scarcely be distinguished exteriorly, whereas in other lineages, such as *Beyrichia,* it becomes progressively more clearly delimited from the rest of the valve, and may even be somewhat constricted at its base. As shown by Hessland (1949, p. 124) and Spjeldnaes (1951, p. 748), the pouch apparently served as a brood pouch. The protection of the young ostracods was presumably a great advantage to the Beyrichiidae, but on the other hand the pouch was a "problem" in relation to balance and harmonic construction of the valves.

As far as I am aware, the family Beyrichiidae is known only from Silurian and Devonian beds, with the possible exception of *Craspedobolbina dietrichi* from the late Upper Ordovician(?). Many Ordovician and post-Devonian species that were originally assigned to beyrichiid genera have later been shown not to belong to the beyrichiid group (see Henningsmoen, 1953, p. 238).

It is not known whether the Beyrichiidae gave rise to any other ostracod families. The beyrichiid genus *Hibbardia* resembles *Amphissites,* and it is not improbable that the Kirkbyidae developed from the Beyrichiidae. Some genera of the family Kloedenellidae show a swelling of the carapace that may be compared with the pouch in the Beyrichiidae. The swelling is not well defined and occupies a posterior position in the valve. In view of the great variation in the shape and position of the pouch in the Beyrichiidae, however (pouch anterior in *Zygosella,* anteroventral in *Beyrichia,* ventral in *Treposella,* and posteroventral in *Hibbardia*), it is not impossible that the Kloedenellidae developed from the Beyrichiidae. Furthermore, the lobation of some kloedenellids resembles that of the Zygobolbinae and Kloedeniinae.

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ABSTRACT: Siphogenerinoides bentonstonei, *n. sp., the oldest known representative of this genus, is listed from two localities in the Coniacian of central Colombia. It shows primitive characteristics in its small size, near-absence of a raised lip bordering the aperture, and in the development of a triserial stage in the megalospheric form.*

A new Siphogenerinoides from the Coniacian of Colombia

C. D. REDMOND
Arabian American Oil Company
Dhahran, Saudi Arabia

INTRODUCTION

The foraminiferal genus *Siphogenerinoides* has not previously been reported from beds older than Campanian. Therefore, the presence of a representative of this genus in the Coniacian of Colombia is considered worthy of special note.

The occurrences described here were first noted while the writer was in the employ of the International Petroleum Company (Colombia) Limited, in Bogota, Colombia.

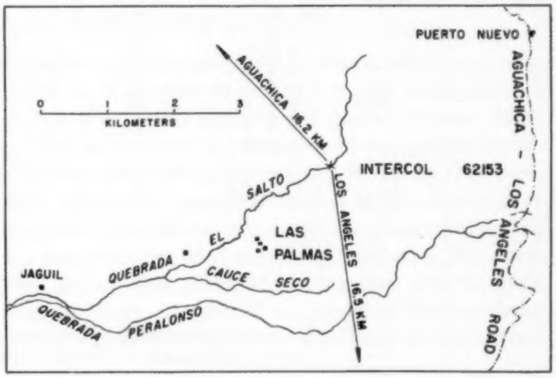
Common specimens of *Siphogenerinoides bentonstonei* Redmond, n. sp., were found in samples from International Petroleum Company (Colombia) Limited sample localities no. 62153 and no. C-7778. The stratigraphic position of sample 62153 is shown in text-figure 2, where it may be seen to lie below the range of *Siphogenerinoides cretacea* Cushman, a Campanian form, and between occurrences of the Coniacian ammonite genus *Barroisiceras*. Sample C-7778 has not been placed in a measured section, but appears to occupy a position comparable to that of sample 62153.

According to a list supplied by Victor Petters (personal communication, March 9, 1953), the following foraminifera occur with S. *bentonstonei* in sample 62153:

Globigerinella sp.
Globotruncana fornicata fornicata Plummer
Globotruncana ventricosa ventricosa White
Gümbelina spp.
Robulus münsteri (Roemer).

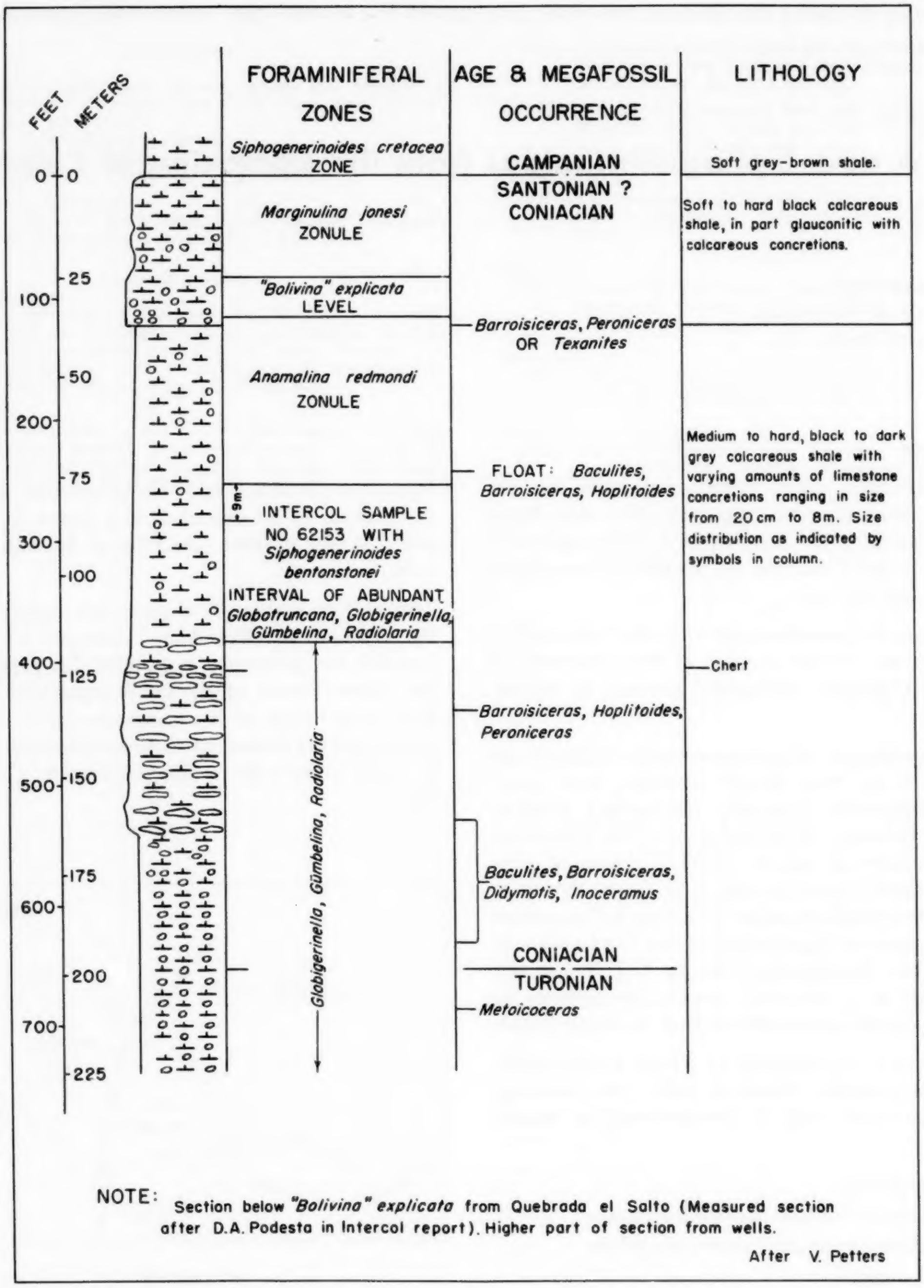
In addition, the assemblage contains new subspecies of *Globotruncana fornicata* Plummer, *Globotruncana lapparenti* Brotzen, and *Globotruncana tricarinata* (Quereau), to be described in a paper by Gandolfi which is now in press (Bulletins of American Paleontology).

The author wishes to express his thanks both to the International Petroleum Company (Colombia) Limited, for permission to publish this paper, and to Dr. Victor Petters of the same organization, for his kind contribution of the composite columnar section and additional faunal list. Acknowledgment must also be made to my wife for the preparation of the drawings.



TEXT-FIGURE 1

Locality map showing position of Intercol sample 62153 in Quebrada el Salto, near the village of Las Palmas, Department of Magdalena, central Colombia.



TEXT-FIGURE 2

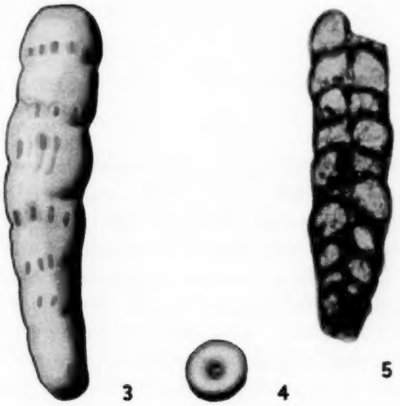
Composite columnar section showing stratigraphic position of *Siphogenerinoides bentonstonei* Redmond, n. sp.

SAMPLE LOCALITIES

In this and in the following sections, the official abbreviation "Intercol" will be used in place of "International Petroleum Company (Colombia) Limited."

Intercol locality no. 62153: In Quebrada el Salto, approximately 1.6 km. northwest of the village of Las Palmas, Department of Magdalena, Colombia. See text-figure 1 for map location.

Intercol locality no. C-7778: 1250 meters S. 7°30′ E. from the crossing of Quebrada el Robo and the trail connecting Corozál and Sabanas de Luis Chiquita, in the southern extension of the Department of Magdalena, approximately 17.5 km. north of the town of Aguachica, on the Gamarra-Ocaña aerial cable line.



3 4 5

TEXT-FIGURES 3-5

Siphogenerinoides bentonstonei Redmond, n. sp. 3, holotype (A.M.N.H. no. FT-1140), side view, × 76. 4, paratype (A.M.N.H. no. FT-1141), apertural view, × 76. 5, paratype (A.M.N.H. no. FT-1142), thin section showing internal siphon, × 78.

SYSTEMATIC DESCRIPTION

Genus Siphogenerinoides Cushman, 1927

Siphogenerinoides bentonstonei Redmond,
new species
Text-figures 3-5

Test elongate, adult specimens four to five times as long as broad, slightly oval to circular in transverse section, greatest diameter near end of biserial portion; microspheric form with pointed initial end, megalospheric form with more bluntly rounded initial end, both generations with tapering initial part of test and uniserial portion with sides nearly parallel; microspheric form with very small proloculum followed by short triserial stage which passes into biserial stage with up to four pairs of chambers and then into uniserial; megalospheric form with small proloculum followed by very short but distinct triserial stage which passes into biserial stage with two or three pairs of chambers and then into uniserial; chambers moderately inflated, indistinct toward initial end but generally distinct toward the apertural end, slightly overlapping; sutures indistinct, depressed, retroflexed in areas where costae are developed; wall thin, calcareous, finely perforate, ornamented by about ten irregularly developed, obscure, discontinuous, low costae which are confined to the proximal ends of the chambers and are not in alignment from chamber to chamber; internal siphon reaching from the initial chambers to the last-formed chamber of the test, siphon twisting approximately 90° per chamber and forming a small, arcuate opening lying outside the aperture and tangent to its straight or slightly concave edge; aperture central, terminal, arcuate, set flush with surface or in slight depression, bordered by a slight lip.

Dimensions of holotype (megalospheric individual): Length 0.80 mm.; width 0.18 mm.; diameter of proloculum approximately 0.06 mm.

Types: Deposited in the collections of the Department of Micropaleontology, American Museum of Natural History, New York; holotype, no. FT-1140; paratype, no. FT-1141; sectioned paratype, no. FT-1142; and six additional specimens, faunal no. 1073. All from Intercol sample locality no. C-7778.

Remarks: Siphogenerinoides bentonstonei, n. sp., conforms in all important respects to the characteristics of the genus as redefined by Benton Stone (1946, p. 469) in his lucid investigation of the genera *Siphogenerina* and *Siphogenerinoides.* It differs, however, from previously described species in the presence of a triserial stage in the megalospheric generation and in the near-absence of a raised lip bordering the aperture. Both points of difference, together with its small size, could be interpreted as primitive characteristics completely in harmony with its position in the section.

REFERENCE

Stone, B.
1946 – *Siphogenerinoides Cushman (Order Foraminifera, Family Buliminidae).* Jour. Pal., vol. 20, pp. 463-478.

ABSTRACT: *The photography of foraminifera and other objects of similar size presents many problems to the novice. The apparatus described makes satisfactory photographs of small objects both rapidly and inexpensively. Many common difficulties in lighting, depth of field, long exposure, and vibration are not encountered in using this device.*

An apparatus for photographing foraminifera and other small objects

N. J. SANDER
Arabian American Oil Company
*New York, New York**

INTRODUCTION

The writer has been interested in the photography of foraminifera since 1938. Many different setups for this work have been used and discarded through the years. The apparatus described here is not ideal, but does make photographs of good quality both rapidly and inexpensively. It can be operated by a technician with a few hours' training. Such a device can be used in a commercial micropaleontological laboratory for recording, instruction and comparison, as well as for making studies of serial sections. The importance of keeping permanent records of "types" which can be stored separately is obvious.

The initial cost of the apparatus will range between $1000 and $1500, if all parts are bought new. The range in cost is a reflection of possible choices in types of lenses, lamps, camera, and microscope used. It is absolutely essential for good results that the lenses be of first quality, the "faster" the better. The quality of the remainder of the equipment is much less important. Second-hand camera boxes, sliding or rotating focusing attachments, extension tubes, microscope lamps, etc., if carefully chosen, will serve as well as new ones, at from one-fourth to one-half the cost.

CONSTRUCTION

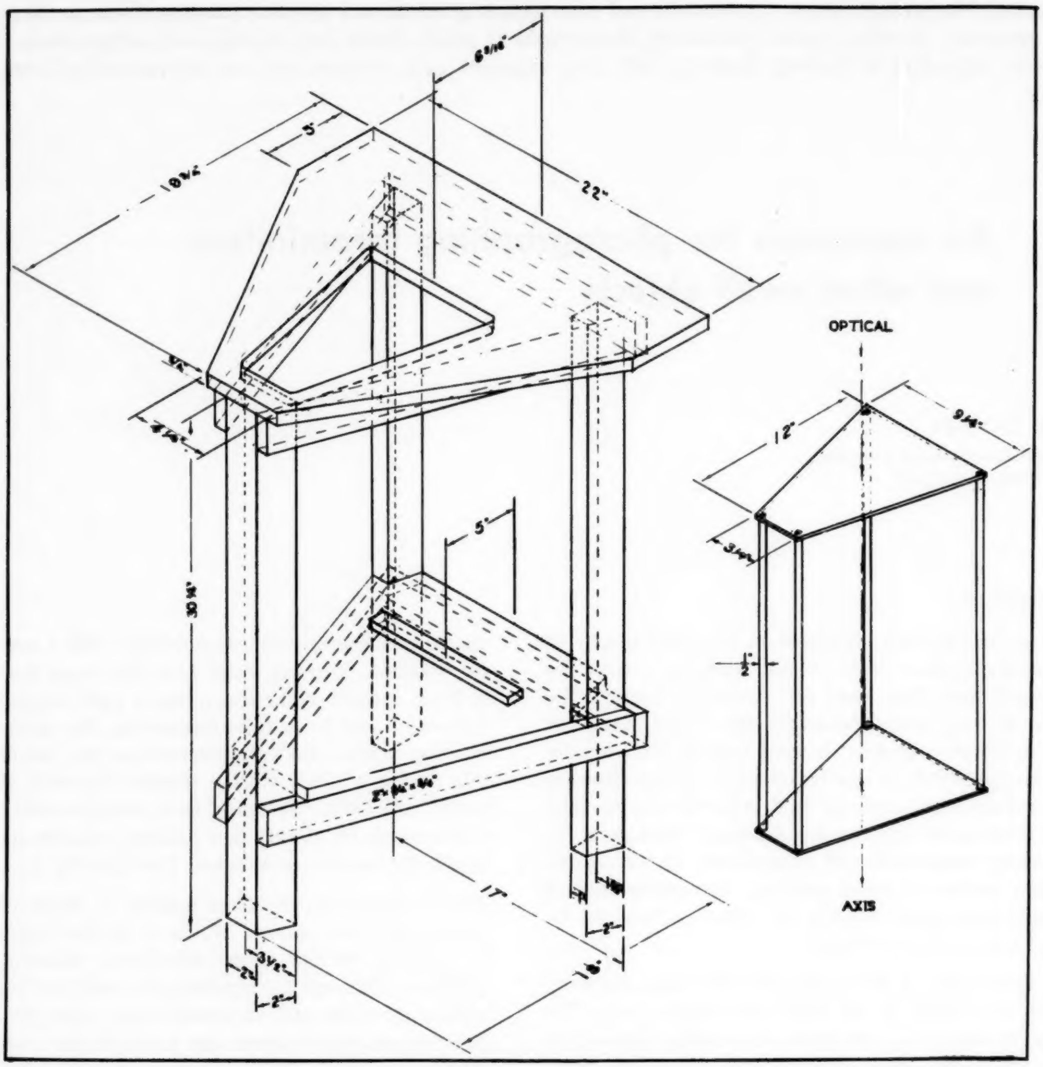
Essentially, as may be seen in the sketches and photographs, the apparatus consists of a microscope with coarse and fine adjustment provided with a mechanical, rotating, focusing stage (i.e., the stage is moved to focus instead of the lens), and a rigid support and light-tight seal for a tube connecting the microscope and the camera. Both the microscope and camera (in this device a Leica with a rotating focusing attachment) are tightly fastened to a stainless-steel metal stand which fits closely in a massive wooden stand to which the lamps are attached (see text-fig. 1).

This construction, in effect making a single unit of microscope and camera which is further supported by a heavy wooden frame, eliminates vibration as a problem. Although the apparatus is used in a building shaken by trains and air-conditioning units, no negative yet processed shows any trace of blur owing to vibration, even in exposures up to five seconds.

LENSES

For reasons discussed below, several lenses, each of a different focal length, must be used to photograph objects of different sizes and thicknesses. It is necessary to machine special adapters to mount some lenses. For the apparatus described, lenses of 8, 16, 24, 32, 35, 50, 75 and 135 mm. focal length are available. The 8 and 16 mm. focal lengths are given by apochromatic microscope objectives; the 24 and 32 mm. lenses are f/4.5 Microtessars; the 35, 50 and 135 mm. are f/4.5 or faster Leitz lenses, and the 75 mm. is an f/2.8 Kern-Paillard 16 mm. motion-picture camera lens. A considerable variety of lenses can be effectively used.

* Now with Conorada Petroleum Corporation, Rome, Italy.



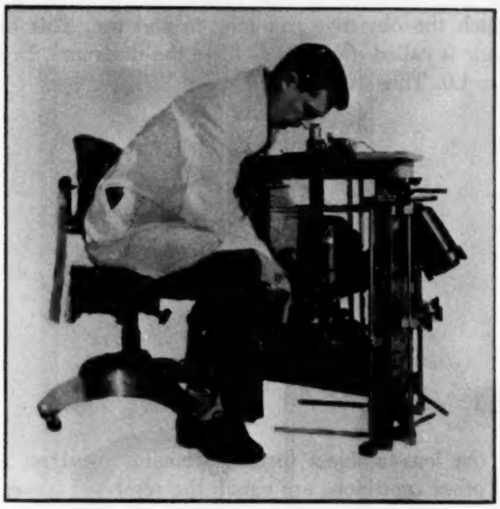
TEXT-FIGURE 1

DETAIL OF WOODEN AND STEEL STANDS

Shorter focal length 16 mm. or 8 mm. motion-picture camera lenses should be valuable to supplement the apochromats which are used primarily for photographs by transmitted light. In short focal-length lenses, the subject is very close to the front element. Lenses with built-in sunshades often cannot be used, because the subject cannot be lighted correctly because of the low angle at which the lamps must be set.

In any event, the lenses used must have large apertures, and preferably diaphragms so that they can be stopped down. Pinhole diaphragms can be made from thin sheet-metal and inserted in microscope objectives or fixed-focus lenses to provide greater depth of field, however.

No ocular is put in the system, for no useful purpose is served by further magnifying the image on the film. A 6× focusing magnifier is set on the ground-glass focusing screen, which has a clear area in the center for critical observation. A 20× magnifier would be useful for very sharp focusing.



TEXT-FIGURE 2

THE APPARATUS IN USE

CAMERA AND FILM

Any 35 mm. camera box with focal-plane shutter, in which lenses are interchangeable, could be adapted for use in this type of apparatus. However, it is convenient to use cameras for which extension tubes and sliding or rotating ground-glass focusing devices are currently available. A 35 mm. single-lens reflex camera might also be adapted, but less easily, since in use the focusing screen would be vertical. The camera box now available for the apparatus is a Leica, which is clamped to a Leitz rotating stage. The ground-glass screen of the stage is coated lightly with castor oil to decrease graininess. Larger film sizes could be used, and for certain purposes a film pack or plate holder up to 6 × 9 cm., preferably with a shutter, would be of value.

Three types of film are now being used: Microfile, a slow (Weston 2), very fine-grained panchromatic high-contrast copy film; Plus-X, a moderately fast (Weston 40), medium-grained panchromatic emulsion; and Kodachrome Type A (Weston 12). When light intensity is not greatly reduced by blue or violet filters on the illuminators, Microfile gives very good results; exposure-time ranges between one-half and one one-hundredth of a second. Plus-X is employed when sharp-cutting filters are used for increased resolution, and exposure-time averages about the same. With Kodachrome and compensating color-temperature filters, exposures range between one-half and one one-hundredth of a second.

Orthochromatic film might be valuable, particularly when blue or violet filters are used. It is fine-grained, moderately fast, and insensitive to red, so that only shorter wave-lengths can affect the emulsion.

ILLUMINATION

Any strong light-source that can be focused on the subject without casting shadows of the filament or having other irregularities in intensity over small areas can be used. It is advisable to have three lamps available for lighting opaque objects. The object is arranged so that shadows can be used to bring out details of the structure. One lamp is set low, so that the light from it is almost grazing. Shadows are then long and dark. A second lamp is set above the subject as closely as possible to vertical, and the third is used to fill in any shadows that remain. It is very important that the difference in light intensities be slight when using Microfile film, because of its high contrast. A difference of one inch in the distances of the light-sources from the object is clearly visible in the shadow intensity of Microfile. Plus-X is somewhat less sensitive in this respect.

In the device pictured (pl. 1, fig. 2), the illumination is by K-100 zirconium arc lamps manufactured by the Sylvania Electric Company from a patent of the Western Union Telegraph Company. These lamps give a very intense light in a small area. The color temperature is 3200° K. This color temperature is correct for Ektachrome, which is now available in 35 mm. cartridges. It must be corrected for Kodachrome Type A, which is balanced for a color temperature of 3400° K. The lamps are mounted in Bausch & Lomb research illuminators, which are satisfactory but produce color fringes around the light spot, even when stopped down somewhat. Better-corrected condensers are commercially available at higher prices.

It is essential that the lamps be freely movable to any position, so that lighting can be to best advantage. A slight change in the arrangement of one or more lamps often improves the quality of the picture. However, lamps must be motionless during the time of exposure.

In selecting illuminators, choose the most intense light-source available in your price range. Ribbon-filament tungsten lamps are satisfactory. Photofloods can be used if care is exercised to insure that they do not overheat the lens. Carbon arcs are reported to flicker, making exposure uncertain. Zirconium arcs give an even, small, high-intensity light-source. Microscope lamps can be used but are of rather low inten-

sity and must be adjusted carefully to avoid focusing the filament image on the subject. Mercury-vapor lamps might prove very satisfactory for black-and-white photography.

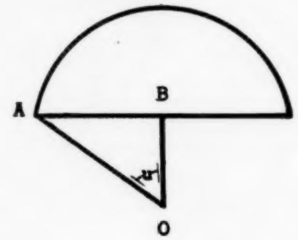
OPERATION

The photographer operates from a seated position (see text-fig. 2). Fossils to be photographed are mounted in groups according to dimensions on a dark-green glass slide. The proper lens is selected for the depth of field required and the size of the fossils, so that the image on the ground glass will be small enough to fit the negative size. The intensity of the light beam of each lamp as reflected from a white card, and the intensity of all three together, are measured at the film plane, and any obvious imbalance is corrected. The slide is placed on the stage, illuminated by the grazing lamp, and one specimen is brought into focus on the ground glass with the lens at full aperture. The microscope stage is rotated to observe the changing position of the shadows. When the best position is established, the other lamp diaphragms are opened and the effect on the shadows observed. Various colored filters with approximately equal transmittance can be used to help adjust the light intensities. The lens is then stopped down sufficiently to bring the entire object into focus. It is necessary to be critical in the initial plane of focus, in order to avoid stopping the lens down more than necessary. If filters are to be used on the illuminators, they are put in the holders. The camera is swung into position and the exposure made.

In routine work, once the light intensities have been properly balanced it is possible to take photographs at the rate of three to four per minute, using the mechanical stage to bring successive fossils into view. However, for best results, more time should be taken to study shadows in order to bring out detail.

DEPTH OF FIELD VERSUS RESOLVING POWER

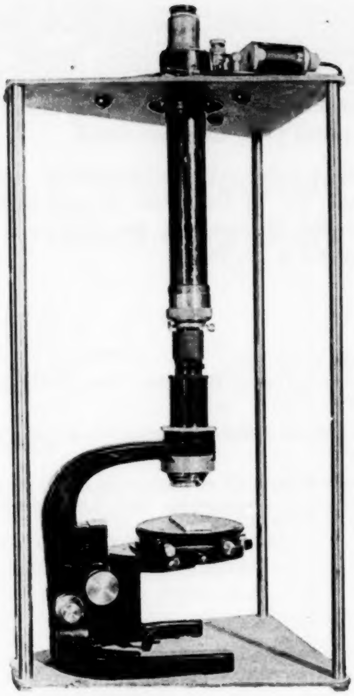
The technique of small initial magnification by lenses of different focal lengths, with subsequent enlargement, has the advantage of giving good depth of field and a relatively short projection distance, which in turn means short exposure time. There are, however, certain disadvantages which can be only partly overcome. For example, only lenses with high numerical apertures have sufficient resolving power to give good results in this apparatus. Numerical aperture (NA) is defined as the refractive index, called n, of the medium in front of the lens, multiplied by the sine of one-half the greatest angle of light rays from the object point which the objective can take in and use. This half-angle is called u (angle AOB in the diagram). In air, $n = 1.0$. Thus $NA = \sin u = \frac{AB}{AO}$.



If the lens-to-object distance remains constant, and all other conditions are equal, the resolving power of a lens is directly proportional to its effective aperture, which in photographic objectives is dependent on physical diameter. Therefore only "fast" lenses will give optimum resolution. For example, to obtain anti-points, otherwise known as the Airy disc or circles of confusion, of 75 microns, to conform to the strictest standard of useful definition a magnification of 25× requires NA .083 = f/5.8; 35×, NA .117 = f/4.3; 50×, NA .167 = f/2.9; 75×, NA .250 = f/2.1; 100×, NA .330 = f/1.4.

To obtain a 50× print in which the resolution equals the strictest standard of useful definition, the taking lens must have an f/number of at least 2.9. However, somewhat less rigid standards, satisfactory for reproduction and ordinary study, can be met by f/openings only half as large. For example, a 50 mm. lens at f/6.3 in this device gives an image enlarged 7× on the negative, which can be enlarged seven more times in the enlarger to give a 49× print satisfactory for reproduction and study. It is not possible to use most miniature-camera and 16 mm. motion-picture camera lenses at full aperture, owing to flare and low contrast, but a "fast" lens can easily be used at f/3.5 or f/4.5.

In this apparatus, the problem of depth of field versus resolving power must be approached by compromise. Usually, resolution is sacrificed for depth of field, particularly in specimens in which recording of finest detail is not important. However, the resolving power of any lens can be improved by decreasing the wave length of the light entering it. Dark blue or violet filters which cut sharply into the lower end of the visible spectrum, such as Wratten filters nos. 76, 35, 45, etc., can be used to approximate monochromatic light of short wave length.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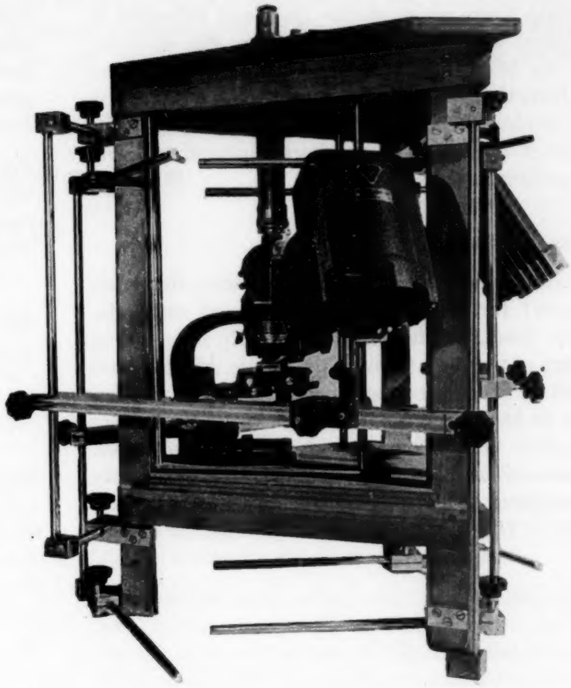
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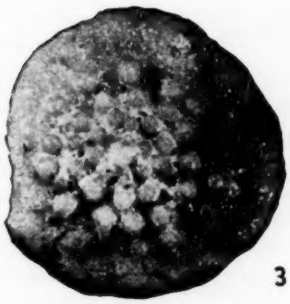
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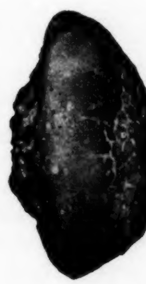
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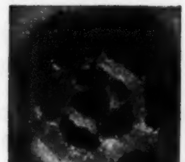
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Polarizing filters set to reduce glare and reflection in the optical system very often reduce the resolving power by 50% or more, as well as tripling exposure time. Sometimes the specimen can be submerged in water, alcohol, or glycerine to reduce reflection, or the position of the lamps or specimen changed to avoid using polarized light.

NOTES ON FILM AND PRINT PROCESSING

Films are processed in Microdol (or other fine-grain developer) for 0.8 gamma and projected on Kodabromide. Dodging, that is, intermittently interrupting a portion of the light forming the image, is sometimes resorted to for decreasing shadow density. It is important to keep gamma low enough so that negatives are slightly thin, although with full shadow detail. Enlargements are much easier to make from relatively thin negatives, grain is usually finer, and contrast is easier to control. Several contrast grades of glossy enlarging paper should be available, because the inherent contrast of the subjects ranges widely, and prints are much clearer on the proper grade of paper. Ferrotyped prints yield the most detail.

For purposes of publication, print contrast should be kept relatively low. If the effect is slightly flat, the reproduction will be excellent, for contrast is nearly always increased in copying.

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EXPLANATION OF PLATE 1

1 Stainless-steel stand holding microscope, light-tight tube, rotating stage, and camera rigidly.

2 Complete assembly. Stand mounted in wooden frame with lamps attached.

3 *Lockhartia tipperi* (Davies), form B. Dorsal view, × 20 (magnification of negative × 4). 75 mm. Paillard lens at f/12.5.

4 *Lockhartia tipperi* (Davies), form B. Peripheral view, × 20 (magnification of negative × 4). 75 mm. Paillard lens at f/16.

5 *Rotalia trochidiformis* (Lamarck). Ventral view, × 35 (magnification of negative × 7). 50 mm. Summar lens at f/12.5.

6 *Nummulites somaliensis* Nuttall and Brighton. Axial section by reflected light, × 4 (magnification of negative × 2). 135 mm. Hektor lens at f/9.

7 *Miscellanea miscella* (d'Archiac and Haime). Lateral view, × 20 (magnification of negative × 4). 75 mm. Paillard lens at f/16.

8 *Rotalia trochidiformis* (Lamarck). Peripheral view of heavy-spired variant, × 20 (magnification of negative × 4). 75 mm. Paillard lens at f/16.

9 *Lockhartia diversa* Smout. Lateral view, × 20 (magnification of negative × 4). 75 mm. Paillard lens at f/16.

10 *Lockhartia tipperi* (Davies), form A. Proloculum of specimen with apex ground down, × 100 (magnification of negative × 26). 16 mm. AO apochromat lens.

ABSTRACT: A Globotruncana *fauna from a sample of the Pecan Gap chalk is reviewed and two forms are described. A species of* Globorotalites *has been examined and its genetic relationship to the genus* Globotruncana *is suggested. The systematic position of this form is discussed, and the validity of the genus* Globorotalites *is questioned.*

A Globotruncana fauna from the Pecan Gap chalk of Texas

R. GANDOLFI
Imperial Oil Company
London, Ontario

INTRODUCTION

This note deals especially with a *Globotruncana* fauna found in a sample of the Pecan Gap chalk of Texas. Thanks are expressed to Dr. Brooks F. Ellis of the Department of Micropaleontology, American Museum of Natural History, New York, who supplied the sample. The writer also wishes to thank Dr. H. Buergl of the Museo Geológico, Bogotá, Colombia, for his assistance in taking the photomicrographs.

The locality and its faunal assemblages have been described by various authors, and special reference is made to Cushman's paper (1944) on the foraminiferal fauna of the type locality of the Pecan Gap chalk.

The sample examined by the writer contains a *Globotruncana* fauna that is very close to that of the Colon and Manaure shales of northeastern Colombia (Gandolfi, MS.). Two species of *Globotruncana* are here investigated. Another form described from this sample is *Globorotalites? micheliniana alabamensis* (Sandidge). This form is common, and at present is not considered a *Globotruncana* by most authors. Its systematic position is discussed below, because its apertural characters suggest a close relationship between this form and the genus *Globotruncana*.

SYSTEMATIC DESCRIPTIONS

Genus GLOBOTRUNCANA Cushman, 1927

Subgenus GLOBOTRUNCANA Cushman, 1927

Globotruncana (Globotruncana) cretacea Cushman

Globotruncana cretacea CUSHMAN, 1938, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 3, p. 67, pl. 11, fig. 6a-c.

The test is double-keeled in the early stages, single-keeled in the adult. The umbilical convexity of the chambers increases very rapidly in such a way that the side wall of the last chamber is nearly at right angles to the roof. The coiling is trochoid in the early stages, becoming flat in the later stages.

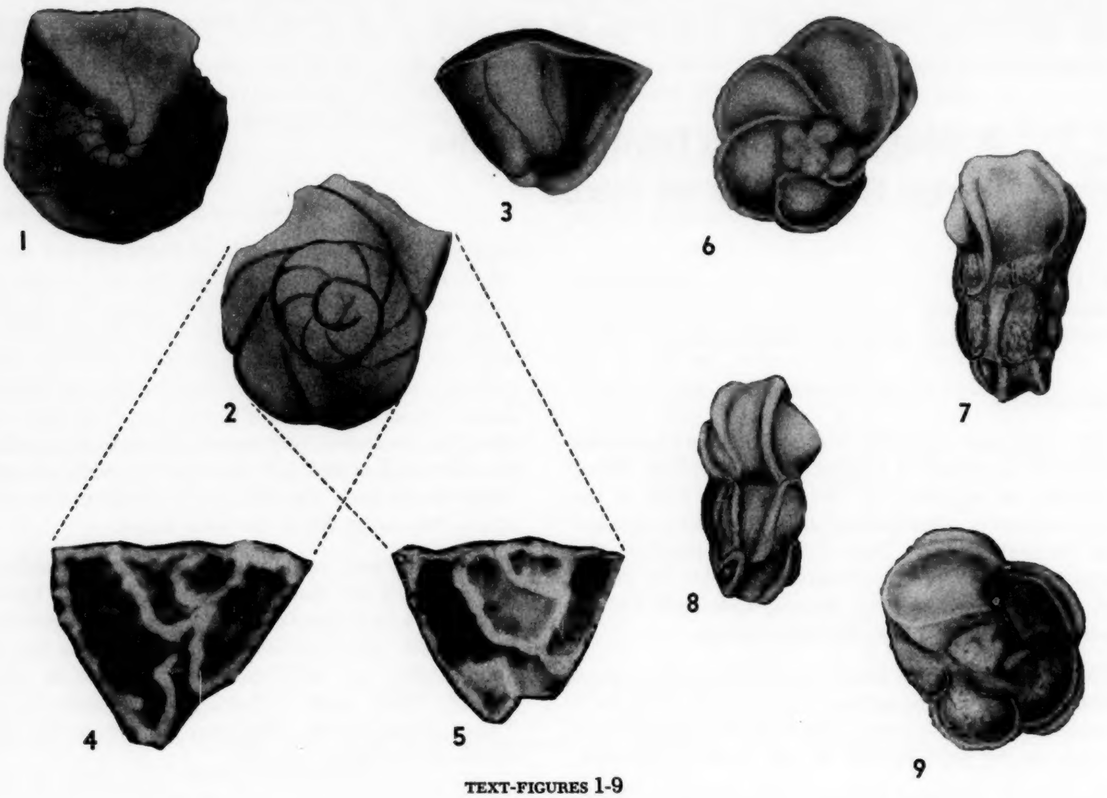
The trochoid early coiling and the increasing height of the chambers are characteristics that can also be observed in a new species of *Globotruncana* described by Gandolfi (MS.), in *Globotruncana flexuosa* van der Sluis (1950), and in *Globotruncana andori* de Klasz (1953), which seem to belong to the same group. These morphological characters appear to be persistent evolutionary features.

Globotruncana (Globotruncana) sp. aff. **tricarinata** (Quereau)
Text-figures 6-9

This form belongs to the "*tricarinata*" type, since it shows a well-developed double keel and high chambers with a pronounced thickening around the umbilicus. In this form, however, the chambers are few, typically inflated along their length, and are arranged more or less obliquely to their plane of coiling. The umbilical sutures tend to become radial and depressed in the early stages of the last coil.

This form may have been identified by Cushman (1944) as *Globotruncana canaliculata* (Reuss), although the specimen illustrated (pl. 3, fig. 8) does not show any inflation of chambers. The original species of Reuss (*Rosalina canaliculata* Reuss, 1854) is, according to Bolli (personal communication), a "*lapparenti*" form, with flat chambers.

This form is interesting because a certain similarity to *Globotruncana mayaroensis* Bolli can be observed. The similar features are imbricated chambers, increasing



TEXT-FIGURES 1-9

1-5, *Globorotalites? micheliniana alabamensis* (Sandidge), all × 90: 1, umbilical view; note the sigmoidal and forward-curving sutures; 2, dorsal view; 3, side view; 4-5, median polished sections, showing the umbilical apertures of the last and penultimate chambers. 6-9, *Globotruncana* sp. aff. *tricarinata* (Quereau), all × 90: 6, dorsal view; 7-8, side views; 9, umbilical view.

height of the test, diverging keels, and depressed radial umbilical sutures. This form is also similar to *Rosalinella globigerinoides* Marie, which has the same characteristics but also has inflated chambers.

Genus Globorotalites Brotzen, 1942

Globorotalites? micheliniana alabamensis
(Sandidge)
Text-figures 1-5

Gyroidina alabamensis Sandidge, 1932, Jour. Pal., vol. 6, p. 238, pl. 43, figs. 13-15.

Globorotalia micheliniana (d'Orbigny). – Cushman, 1944, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 1, p. 15, pl. 3, fig. 13.

The test is nearly flat dorsally and is strongly convex on the umbilical side. The chambers are curved and overlap each other with sigmoidal umbilical sutures. The umbilicus is distinctly open, at least in the last whorl, comparatively large, but closed in the earlier part of the test. The chambers communicate with each other through fine lateral slits, which constitute the main marginal aperture of the last chamber. At least two adult chambers in the last whorl possess an additional aperture which is small and opens into the umbilicus.

This interesting apertural feature was observed in polished section. In polishing the section, the marginal aperture disappears completely and the additional aperture appears only in the later stages of preparation. In an attempt to clarify this feature, another specimen which was not filled with matrix was chosen for preparation. The outer wall of the last chamber was cautiously cut with a razor blade, and fortunately this delicate operation was successful. It was possible

to see into the opened chamber and observe the marginal aperture between the penultimate and the last chamber, as well as the separate and distinct umbilical aperture, which opened directly into the umbilicus.

The coiling of the test is predominantly dextral. One sinistrally coiled specimen was found in a total of twelve specimens. The dimensions of the figured specimens are: 0.44 × 0.32 mm. (figs. 1-3); 0.38 × 0.30 mm. (fig. 4); and 0.46 × 0.34 mm. (fig. 5). The umbilicus measures 0.04 to 0.08 mm. in width, and 0.10 to 0.13 mm. in depth.

Sandidge (1932) first noted the presence of a large umbilicus in his American form, which was not indicated by d'Orbigny in the original description or illustration of *"Rotalina" micheliniana* from the Paris Basin (d'Orbigny, 1840). Consequently, Sandidge separated the American form from the more involute European form and assigned it to the genus *Gyroidina*. Later authors, however, continued to identify the Pecan Gap form as *Globorotalia micheliniana* (d'Orbigny), chiefly on the authority of Cushman. Brotzen (1942) also noted the deep umbilicus of some of the American forms, and noted that the French forms showed a closed umbilical side, with a few exceptions. A few tests were characterized by a very small open umbilical cavity, which is not at all like that of the American form. He therefore included the American and European forms in his newly erected genus *Globorotalites*. It now appears reasonable to separate the French and American forms, in agreement with Sandidge. The American form has peculiar apertural details that are not present or are rudimentary in d'Orbigny's form.

Another form apparently similar to those described above is *Globorotalia subconica* Morrow (1934). Structural details are similar, and it has a comparatively large umbilicus. It is possible that this form should be assigned to the same group as *Globorotalites? micheliniana alabamensis.*

The structural details of *Globorotalites? micheliniana alabamensis,* particularly the umbilical apertures, indicate that this form developed from the genus *Globotruncana*. According to Brotzen, however, an unnamed form of Turonian age, as well as *Globorotalia multisepta* Brotzen, 1936, of lower Senonian age, show an involute umbilicus. If an involute umbilicus is assumed to be an advanced characteristic, then well-developed *Globorotalites* tests appear prior to the development of *Globorotalites? micheliniana alabamensis* (Sandidge), which is not believed to occur earlier than the Campanian. It therefore seems that several independent species of *Globorotalites* may have evolved from *Globotruncana* along parallel lines over a comparatively long period of time, Turonian to Maestrichtian.

Another possibility is that some early so-called *Globorotalites* may have developed from other forms such as *Eponides* or *Epistomina,* as suggested by Brotzen (1942). In either case, the validity of *Globorotalites* as a genus may be questioned. It therefore warrants further investigation.

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ABSTRACT: *Relatively few studies of Mesozoic or Tertiary fossil spores and pollen have been reported. This paucity of information is a handicap to the stratigraphic paleontologist, because these microfossils often can be used for correlating deposits that lack other diagnostic fossils. Extensive studies of these microfossils are needed if they are to become useful correlation tools. Forty-six spore and pollen types and two other organic microfossils, including a hystrichospherid, are described from the Eocene Potreritos and Las Flores formations in the Maracaibo Basin of Venezuela.*

Pollen, spores, and other organic microfossils from the Eocene of Venezuela

W. L. NOREM

California Research Corporation
La Habra, California

INTRODUCTION

A review of the literature shows that Carboniferous and Quaternary spores and pollen have been investigated actively, but relatively few studies of these microfossils in Mesozoic or Tertiary sediments have been reported. This paucity of information is a handicap to the stratigraphic paleontologist because spores and pollen often can be used to correlate deposits that lack other diagnostic fossils. Extensive studies of these microfossils are needed if they are to become useful correlation tools.

Hereafter, in this paper, the term "spore" will be used for both pollen and true spores. When referring to fossils, this use of the term is not correct in the strict botanical sense, because pollen, at the time of dissemination, have developed more than one nucleus and are no longer spores.

The botanical basis for spore analysis was presented by Wilson (1946, p. 111) and Hansen (1947, p. 6). These principles may be summarized as follows: Spores from the plants growing on the land area around a depositional basin are carried by wind and water into the basin, and are buried with the sediments. Under favorable conditions, exines of some of these micro-organs are preserved and form a partial record of the vegetation. Like other fossils, this record of plant life forms the basis for paleontologic correlation and dating of the sediments. The important difference between spores and many of the other fossil groups used for correlation purposes is that most spores are derived from sources outside the depositional basin, and are independent of the aquatic environment up to the time of deposition.

Forty-six spore types were found in samples from three wells (LL-383, Zulia 1L-1 and Zulia 7G-1) in the Maracaibo Basin of northwestern Venezuela (text-fig. 1). The wells penetrate a sequence of sedimentary rocks that have been correlated with the Potreritos and Las Flores formations (Sutton, 1946) in the type areas by means of lithology, mineralogy, and paleontology. The rocks are believed to be upper Eocene in age.

When fossil spores are separated from the matrix of siliceous rocks, other bits of plant and animal tissue are segregated also. Most of these materials have decomposed beyond recognition, or are not distinctive enough in form or limited enough in range to be used as diagnostic fossils. However, some of these micro-organs, such as the hystrichospherids, may be used for paleontologic correlation when their ranges become known more definitely.

Most of these other organic microfossils were not produced under the same environmental conditions as the spores with which they are found. Many are parts of aquatic organisms, some of which lived in marine waters, others in nonmarine environments, and a few may have lived in both. The hystrichospherids, for example, are assumed to be cysts of marine organisms,

TEXT-FIGURE 1

MAP SHOWING WELL LOCATIONS

although their taxonomic position is unknown. Wetzel (1933) concluded that they were probably Protozoa closely related to the flagellates or to radiolarian-like rhizopods. If the hystrichospherids were pelagic organisms, the fossils would probably not be restricted to a single facies. On the other hand, if they were benthonic, they may have been restricted to relatively narrow ecologic zones. In the past, the narrow stratigraphic zones of some fossil types have been attributed to a short geologic life-span, instead of restricted environmental tolerances, and the zones have been assumed erroneously to be time-parallel. Caution must be exercised, therefore, in interpreting the stratigraphic relationships of fossils of unknown affinities. Two such organic microfossils of unknown parentage, including a hystrichospherid, were found in the Las Flores formation of the Maracaibo Basin. They also have been described and illustrated to record their presence.

Ideally, fossil spores should be identified by the generic and specific names of the parent plant. Insofar as they are known, the ecologic relationships could then be used as an aid in stratigraphic interpretation. It is often difficult or impossible, however, to establish the affinities of these microorgans. Therefore, a numerical reference, as suggested by Cross (1950, p. 67), is used in the following descriptions.

Distribution of the microfossils in the three wells is shown in Table 1. The forty-eight types are not all necessarily stratigraphically diagnostic. They are described and illustrated only to record their presence in tropical Eocene deposits without any other implication regarding their stratigraphic significance. They were separated from the siliceous rock samples by the hydrofluoric acid method previously described (Norem, 1953).

The writer is indebted to Creole Petroleum Corporation and Richmond Exploration Company for samples used in this study.

DESCRIPTIONS

Type 1: Plate 1, figure 1. Nonaperturate; shape spheroidal; size $31 \times 32\mu$; surface gemmate (gemmae globular in shape and irregular in size); wall moderately thick.

Type 2: Plate 1, figure 2. Nonaperturate; shape spheroidal; size $40 \times 41\mu$; surface psilate; wall 2.5μ thick.

Type 3: Plate 1, figure 3. Nonaperturate; shape spheroidal; size $45 \times 47\mu$; surface subspsilate; wall 3.5μ thick.

Type 4: Plate 1, figures 4a and 4b. Nonaperturate; shape spheroidal; size (4a) 39μ, (4b) 52μ; surface markings coarsely reticulate (muri, at least around the limb pierced, giving appearance of loops); wall moderately thick.

Type 5: Plate 1, figure 5. Nonaperturate; shape spheroidal; size 54μ; surface markings finely and irregularly reticulate; wall moderately thick.

Type 6: Plate 1, figure 6. Nonaperturate; shape spheroidal; size $20 \times 23\mu$; surface markings spinose (slender, pointed spines 3.5μ long); wall moderately thick.

Type 7: Plate 1, figure 7. Nonaperturate; shape spheroidal; size 25μ; surface markings subspinose (blunt spines 1μ long); wall moderately thick.

Type 8: Plate 1, figure 8. Nonaperturate; shape spheroidal; size $37 \times 38\mu$; surface markings subspinose (blunt spines 1.0-1.5μ long); wall moderately thin.

Type 9: Plate 1, figure 9. Nonaperturate; shape spheroidal; size $25 \times 29\mu$; surface markings latituberose (tubercles irregular in size and shape); wall moderately thick.

Type 10: Plate 1, figure 10. Triforate; shape triangular; size $20 \times 20\mu$; surface slightly granulate; wall moderately thick.

TABLE 1

Formation	Zulia 1L-1		Zulia 7G-1		LL-383	
	Depth Interval (ft.)	Microfossil Types	Depth Interval (ft.)	Microfossil Types	Depth Interval (ft.)	Microfossil Types
Las Flores	3495	8, 27, 33, 38	7400	3, 30	4506–4520	47
	3500	24, 37	7440	22	4560–4586	18
	3600	5, 29, 39	7690	16	4747–4765	10
	4140	25, 48	7975	32, 36	5081–5099	1, 13, 17
	4645	14	9125	35, 42	5189–5206	4, 9, 23
	5440	2, 6, 7, 12, 15, 20, 21, 34, 41, 43, 46	10,530	4		
			11,004	19, 31		
	6110	26, 28				
	7660	44				
Potreritos	8088	11				
	8998	45				
	12,002	40				

STRATIGRAPHIC DISTRIBUTION OF MICROFOSSILS

Type 11: Plate 1, figure 11. Tricolpate; shape prolate; size $29 \times 22\mu$; surface very finely granulate; wall moderately thick.

Type 12: Plate 1, figure 12. Tricolpate; shape prolate; size $33 \times 24\mu$; surface very finely granulate; wall moderately thick.

Type 13: Plate 1, figure 13. Triplanicolpate; shape subtriangular; size $22 \times 22\mu$; surface very finely granulate; wall moderately thick.

Type 14: Plate 1, figure 14. Tetraliricolpate; shape tetragonal; size $54 \times 62\mu$; surface very finely granulate; wall moderately thick.

Type 15: Plate 1, figure 15. Tricolpate; shape spheroidal; size 23μ; surface reticulate; wall moderately thick.

Type 16: Plate 1, figure 16. Tricolpate; shape spheroidal; size $35 \times 37\mu$; surface finely reticulate; wall 1.5μ thick.

Type 17: Plate 1, figure 17. Tricolpate; shape prolate; size $24 \times 12\mu$; surface very finely reticulate; wall moderately thick.

Type 18: Plate 1, figure 18. Tricolpate; shape prolate; size $22 \times 13\mu$; surface finely reticulate; wall moderately thick.

Type 19: Plate 1, figure 19. Tricolpate (colpae nearly full-length); shape prolate; size $26 \times 16\mu$; surface finely reticulate; wall moderately thick.

Type 20: Plate 1, figure 20. Tricolpate; shape prolate; size $38 \times 25\mu$; surface very finely reticulate; wall moderately thick.

Type 21: Plate 1, figure 21. Tricolpate; shape prolate; size $44 \times 33\mu$; surface very finely reticulate; wall moderately thick.

Type 22: Plate 1, figure 22. Tricolpate; shape prolate; size $44 \times 35\mu$; surface very finely reticulate; wall 1μ thick.

Type 23: Plate 1, figure 23. Tricolpate; shape prolate; size 52 × 35μ; surface very finely reticulate (reticulations are so fine that they cannot be recognized with certainty); wall moderately thick.

Type 24: Plate 1, figure 24. Triplanicolpate; shape triangular; size 53 × 58μ; surface reticulate; apices finely reticulate; wall moderately thick, thickened at the colpae.

Type 25: Plate 2, figure 25. Triplanicolpate (colpae narrow and short); shape triangular; size 60 × 63μ; surface reticulate, apices finely reticulate; wall moderately thick.

Type 26: Plate 2, figure 26. Tetracolpate (colpae extending two-thirds to poles); shape tetragonal; size 23 × 26μ; surface very finely reticulate; wall moderately thin.

Type 27: Plate 2, figure 27. Tetracolpate (deeply cleft, colpae extending one-half to poles); shape spheroidal; size 36 × 37μ; surface finely reticulate (reticulations slightly coarser in polar areas); wall thin.

Type 28: Plate 2, figure 28. Pentacolpate (colpae extending two-thirds to poles); shape pentagonal; size 23 × 24μ; surface very finely reticulate; wall moderately thick.

Type 29: Plate 2, figure 29. Tricolporate (colpae nearly full length of grain); shape prolate; size 22 × 17μ; surface very finely granulate; wall moderately thick.

Type 30: Plate 2, figure 30. Tricolporate (colpae nearly full length); shape prolate; size 20 × 13μ; surface psilate; wall moderately thick.

Type 31: Plate 2, figure 31. Triliriporate; shape triangular; size 14μ; surface very finely granulate; wall moderately thick.

Type 32: Plate 2, figure 32. Triliriporate (pores slightly aspidate); shape spheroidal; size 38 × 40μ; surface slightly granulate; wall 2.5μ thick.

Type 33: Plate 2, figure 33. Triliriporate; shape triangular; size 25 × 25μ; surface psilate; texture finely granulate; wall 2μ thick.

Type 34: Plate 2, figure 34. Triliriporate (pores small); shape triangular; size 20 × 20μ; surface very finely reticulate; wall moderately thin (slightly more dense around pores).

Type 35: Plate 2, figure 35. Triliriporate (pores slightly aspidate); shape triangular; size 25 × 26μ; surface very finely reticulate; wall moderately thick.

Type 36: Plate 2, figure 36. Triliriporate (pores slightly aspidate); shape triangular; size 22 × 22μ; surface subspinose (spines about 1μ long); wall moderately thick.

Type 37: Plate 2, figure 37. Triliriporate (pores slightly aspidate); shape triangular; size 25 × 25μ; surface subspinose; wall thin.

Type 38: Plate 2, figure 38. Triliriporate (pores slightly aspidate); shape triangular; size 32 × 36μ; surface subspinose; wall moderately thin.

Type 39: Plate 2, figure 39. Monosulcate (aperture full length of grain); shape oblate-lenticular; size 23 × 36μ; surface finely reticulate; wall moderately thick.

Type 40: Plate 2, figure 40. Monosulcate (aperture full length); shape oblate-lenticular; size 16 × 13μ; surface subspinose; wall moderately thick.

Type 41: Plate 2, figure 41. Monolete (aperture slightly crassimarginate, full length with dehiscence fissure); shape oblate; size 36 × 51μ; surface verrucose (low rounded bumps); wall moderately thick.

Type 42: Plate 2, figure 42. Monolete(?) (aperture full length); shape oblate; size 26 × 34μ; surface reticulate, pitted; wall moderately thick.

Type 43: Plate 2, figure 43. Monolete (aperture crassimarginate, full length); shape oblate; size 41 × 53μ; surface irregularly reticulate with granulate texture; wall moderately thick.

Type 44: Plate 2, figure 44. Trilete (aperture slightly crassimarginate, extending to equator); shape triangular; size 26 × 29μ; surface psilate; wall thin.

Type 45: Plate 2, figure 45. Trilete (aperture extending one-half to equator); shape triangular; size 40 × 44μ; surface psilate; wall 3μ thick.

Type 46: Plate 2, figure 46. Trilete (aperture extending one-third to equator with dehiscence fissure); shape spheroidal; size 72 × 79μ; surface psilate; wall 2.5μ thick.

Type 47: Plate 2, figure 47. Hystrichospherid; a cyst of unknown affinities. Thin-walled body 52 × 65μ; appendages united into groups with flat, spreading tops, 17μ long.

Type 48: Plate 2, figure 48. Organic microfossil; longitudinal ridges with equatorial row of pits extending into or through ridges; shape prolate; size 35 × 23μ; surface very finely granulate; wall 1μ at poles, 3.5μ at equator.

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EXPLANATION OF PLATES

PLATE 1

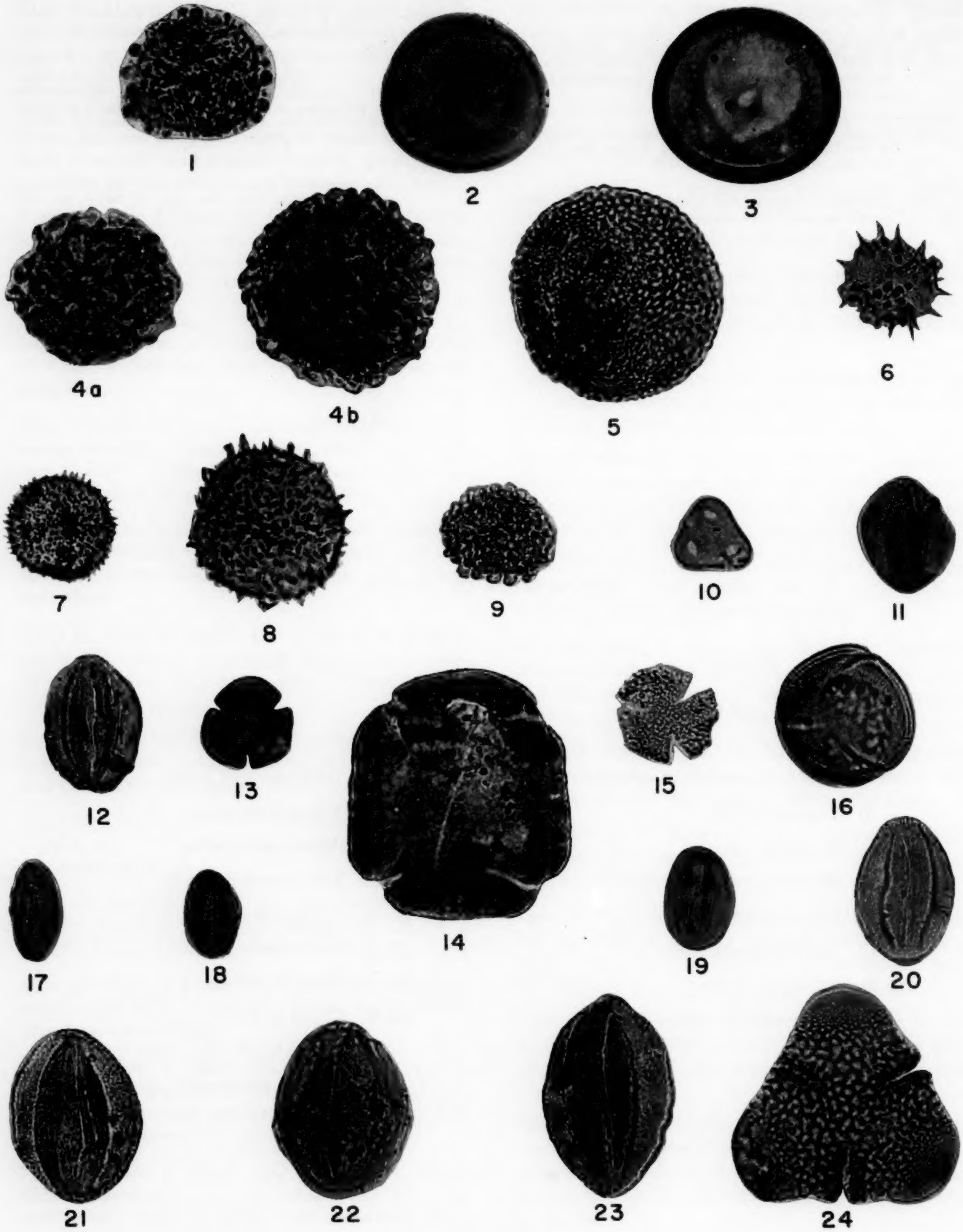
All figures × 750.

1–9	Nonaperturate spores or pollen
10	Triforate pollen
11	Tricolpate pollen
12	Tricolpate pollen
13	Triplanicolpate pollen
14	Tetraliricolpate pollen
15–23	Tricolpate pollen
24	Triplanicolpate pollen

PLATE 2

All figures × 750
unless otherwise noted.

25	Triplanicolpate pollen
26–27	Tetracolpate pollen
28	Pentacolpate pollen
29–30	Tricolporate pollen
31–38	Triliriporate pollen
39–40	Monosulcate pollen
41–43	Monolete spores
44–46	Trilete spores
47	Hystrichospherid, × 500.
48	Organic microfossil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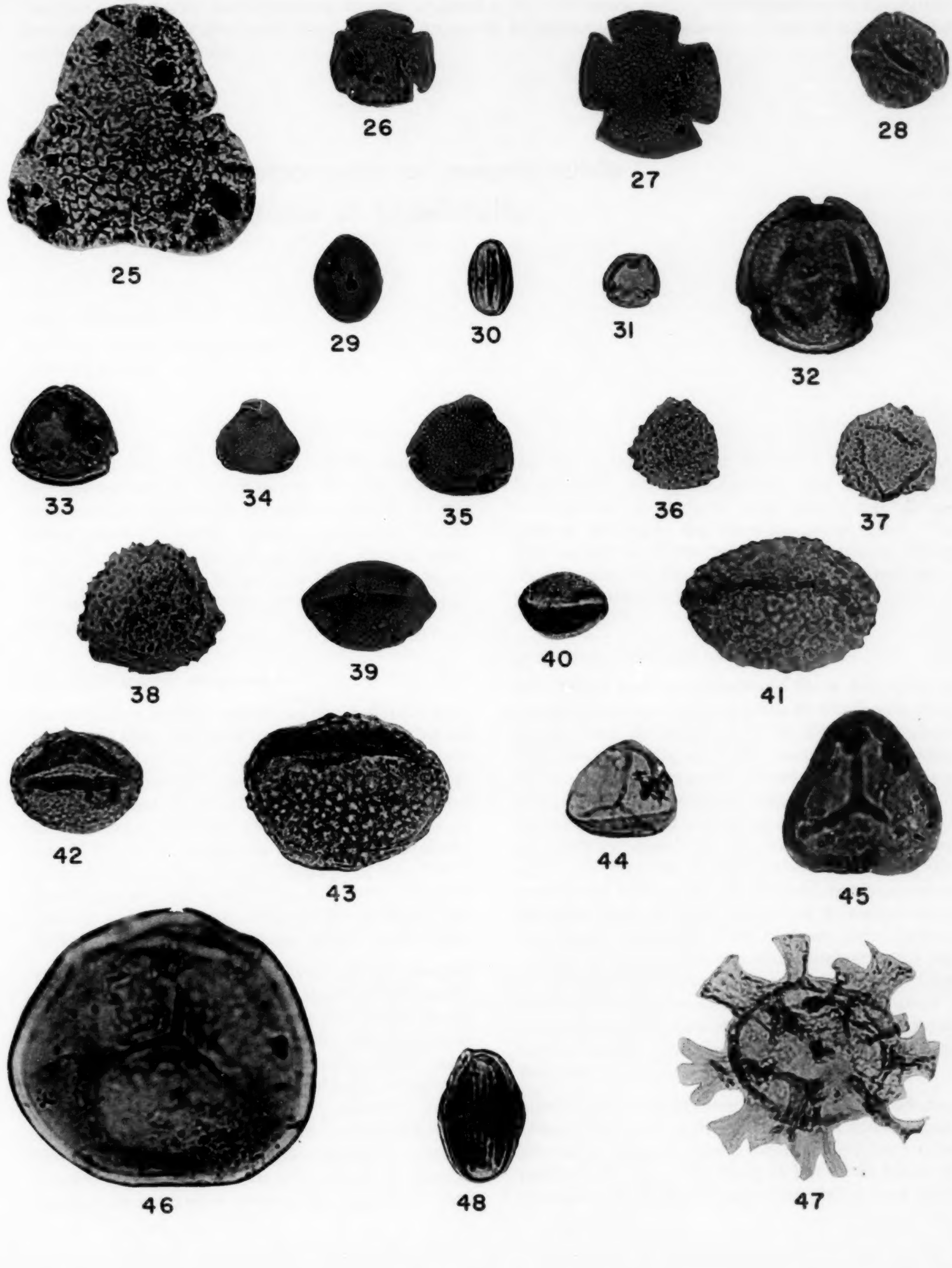
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ABSTRACT: *During the past few years, numerous reports of the occurrence of the foraminiferal genus* Choffatella *have appeared in the literature. Many of them appear to be erroneous. Consequently, a critical review of the genus seems to be in order.*

On some erroneous or questionable determinations of Choffatella

WOLF MAYNC
Venezuelan Atlantic Refining Company
Caracas, Venezuela

Scattered through the literature on micropaleontology that has reached the writer during the past years are some remarks concerning occurrences of the foraminiferal genus *Choffatella,* not all of which are judged to be based on irrefutable evidence. Hence, some critical comments are believed to be appropriate, so that misinterpretations of the genus may be avoided in the future.

CHOFFATELLA STENZELI STEAD, 1951

The erroneous generic assignment of *Choffatella stenzeli* Stead, 1951, has been pointed out by the writer (Maync, 1953, p. 46). Those familiar with *Choffatella* and other spirocyclinine genera will not agree that the haplophragmoid foraminifer figured from the Glen Rose formation of Texas (Stead, 1951, p. 590, pl. 1, figs. 27-30) is a *Choffatella.* The specimens photographed by transmitted light (ibid., pl. 1, figs. 27-28) show a simple interior structure, and there is no evidence of labyrinthic walls or septa. Mr. Stead has not replied to the author's criticism of his classification.

"Choffatella" stenzeli was recently placed in synonymy with *Phenacophragma assurgens* Applin, Loeblich and Tappan, 1950, described from the Glen Rose formation of Texas (Frizzell, 1954, p. 60). The diagnostic feature of the non-labyrinthic genus *Phenacophragma* is, however, the presence of normal septa alternating with short partitions (semisepta), whereas Stead's form appears to possess only normal septa. Moreover, *Phenacophragma* shows a slit-like aperture, whereas *"Choffatella" stenzeli,* on the other hand, is reported to have a linear series of pores on the septal face. Since the two forms also differ externally (compare text-fig. 4, p. 77, in Applin, Loeblich and Tappan, 1950, with figs. 29-30, pl. 1, in Stead, 1951), they do not seem to belong to the same species or genus. The final answer as to the taxonomic position of *"Choffatella" stenzeli* Stead cannot be given without a restudy of the original material.

CHOFFATELLA ZIREGGENSIS SIGAL, 1952

Not having had an opportunity for a first-hand examination of topotype specimens of *Choffatella zireggensis,* from Hauterivian beds of Djebel Zireg, near Bou Saâda, Algeria, the writer feels that it is premature to make any conclusive statements on this form. The published figure (Sigal, 1952, p. 12, text-fig. 4) is probably somewhat schematic, and the twisted specimen may be secondarily deformed. Its greatest diameter is 2.7 mm., its thickness about 0.5-0.6 mm. Externally the test appears chofatelloid, but its apertural character does not seem to warrant its assignment to the genus *Choffatella.* The Algerian form shows a cribrate aperture, with numerous openings evenly distributed over the entire apertural face, whereas *Choffatella* is characterized by one vertical row of pores in a linear groove. In this respect, *Choffatella zireggensis* rather suggests some chofatelloid species of the genus Pseudocyclammina.

Sigal points out that there appears to be a very close affinity between *Choffatella zireggensis* and the genus *Anchispirocyclina,* a genus which differs from *Choffatella* in having a thin layer of buttresses below the reticulate subepidermis, and which differs from *Spiro-*

cyclina in lacking the annular or reniform adult stage. The nature of the aperture of *Anchispirocyclina* is not yet known (Jordan and Applin, 1952). Since nothing has been published on the interior structure of *Choffatella zireggensis* Sigal, the generic status of this form is considered questionable.

CHOFFATELLA IN THE JURASSIC OF CUTCH

The presence of *Choffatella* in Jurassic strata of Cutch, western India, was reported by S. R. N. Rao (1954). Although it is expected that a true representative of *Choffatella* will one day be found in Lower Cretaceous rocks somewhere in the Far East (see Maync, 1950, p. 535), its reported occurrence in beds that are dated by ammonites as undoubted Jurassic (Kimmeridgian—Tithonian) seemed rather questionable. The writer therefore got in touch with the Paleontological Laboratory of the Assam Oil Company, Limited, at Digboi, Assam, India. The writer wishes to express his appreciation to the management of the Assam Oil Company and to its paleontologist, Dr. Y. Nagappa, for sending him specimens of "*Choffatella*" and for permission to publish on them.

A slide labelled "?*Choffatella*, Chari stage, Cutch (India)," containing twenty specimens, was received. The locality is given as "Jumara Dome (map reference Survey India 41 E, 1″ = 4 miles)." Before mailing the slide, Dr. Nagappa briefly restudied the form under discussion, and himself had some doubts as to the correctness of the previous generic assignment (letter to the writer).

An examination of this form revealed the following characters: Test strongly flattened, transparent, consisting of a trochoid spire; about three whorls visible on the dorsal side, five to seven chambers of the last whorl visible on the ventral side; outline lobulate, the last-formed chamber usually strongly inflated and sometimes more loosely appressed. Wall very thin, finely arenaceous. Maximum diameter 0.2 mm., least diameter 0.05 mm. Character of the aperture not recognizable. Interior structure simple, not labyrinthic, and not at all choffatelloid. The slightly curved septa are also simple, not pierced by regular passages.

There is, consequently, no reason to refer this form to *Choffatella*, inasmuch as it lacks all the characters of that genus. The specimens studied from the Jurassic of Cutch should, rather, be assigned to *Trochammina*. With respect to outline and size of test, they are scarcely distinguishable from *Trochammina callima* Loeblich and Tappan, from the Lower Cretaceous (middle Albian) Kiowa shale of Kansas (Loeblich and Tappan, 1950, pl. 1, fig. 23; pl. 2, figs. 4-5).

CHOFFATELLA SOGAMOZAE (KARSTEN) PETTERS

Another species of *Choffatella* was recently introduced into the literature by V. Petters (1954). This form, from Lower Cretaceous (Barremian—?Hauterivian) beds of Colombia, had been described as *Robulina sogamozae* by Karsten (1858). It was subsequently shown that *Robulina sogamozae* Karsten and *Planulina zapatocensis* Karsten, 1858, are synonymous (Dietrich, 1935). Both forms were, moreover, found to have an arenaceous test and a simple (non-labyrinthic) interior structure, because of which they were referred to the genus *Haplophragmoides* by Dietrich (1935).

Petters (1954) concluded that the wall structure of *Robulina sogamozae* is labyrinthic. Moreover, he presented some additional data on the nature of the aperture, which is formed either by a short vertical row of a few large pores on the septal face (Petters, 1954, p. 133, text-fig. 5d) or by a usually elongate, often irregular crenulate opening (ibid., text-figs. 5b, 5f, 5h, 6b, 6d; pl. 24, fig. 2). It is conceivable that the first-mentioned type of aperture results from the intergrowth of the lateral tooth-like processes of the large irregular opening.

Petters classified the wall structure of this form as coarsely labyrinthic, or pseudocyclamminoid, and regarded its aperture as choffatelloid. Since he apparently considers the characters of the aperture to be taxonomically more important than the interior structure, he placed *Robulina sogamozae* and its synonym *Planulina zapatocensis* in the genus *Choffatella*.

In the writer's opinion, however, such an assignment is not warranted. None of the specimens of "*Choffatella*" *sogamozae* hitherto figured shows an external resemblance to *Choffatella* (see Karsten, 1858, pl. 6, figs. 4a, 4c, 5a, 5b; Petters, 1954, pl. 24, figs. 1-2). They are coarser, more irregular, and consist of considerably fewer chambers in their last entirely coiled whorl (five to nine). Externally, some of the coarsely arenaceous specimens are like *Haplophragmoides* or *Cyclammina*, except for the aperture. Others uncoil like *Ammobaculites* (four uncoiled chambers).

Thanks to the kindness of Dr. Petters, the writer was enabled to thin-section and study some topotype material, for which he wishes to express his appreciation here. The test is bilaterally symmetrical, not completely involute, and shows a broadly subacute periphery. The diameter of the specimens examined varies between 0.8 and 2.0 mm. The aperture is apparently an irregular vertical slit, and the supposed pores may have been simulated by weathering of the granular test in the apertural depression.

"Choffatella" sogamozae does not possess a labyrinthic interior structure, but shows coarsely arenaceous simple walls, and septa formed by the agglutination of rather evenly sized sand grains. The septal sutures are clearly visible externally, but thin sections reveal that the corresponding septa are usually obscure, irregular, or interrupted, because of the coarseness of the agglutinated material. The published thin section (Petters, 1954, pl. 24, fig. 3) also fails to disclose any trace of alveoles or passages in either walls or septa, and there is no trace of an alveolar subepidermal layer.

Consequently, the Colombian form is not a member of the spirocyclinine group of lituolid foraminifera, and therefore cannot be referred to *Choffatella* or *Pseudocyclammina*. *"Choffatella" sogamozae* (Karsten) should be placed in the non-labyrinthic subfamily Haplophragmoidinae Maync. Because of the different aperture, however, *"Choffatella" sogamozae* cannot be assigned to the genus *Haplophragmoides*.

Buccicrenata Loeblich and Tappan, 1949, is a lituolid genus which possesses a non-labyrinthic interior and externally resembles *"Robulina" sogamozae*. The genoholotype is *Ammobaculites subgoodlandensis* Vanderpool, 1933. Both species show a medium to coarsely arenaceous texture, and consist of an initial, more or less regular spire, which usually uncoils in the adult. An irregular, elongate, crenulate aperture is common to both forms, according to Loeblich and Tappan (1949, pl. 47, figs. 11-12) and Petters (1954, text-figs. 5-6; pl. 24, fig. 2). Thin sections of *Buccicrenata subgoodlandensis* disclose no sharply defined septa, a feature which was also noted in some specimens of *"Robulina" sogamozae*. The latter may, therefore, represent another species of *Buccicrenata*, differing from *Buccicrenata subgoodlandensis* in its smaller, more regular involute test. The Colombian form from the Hauterivian-Barremian has, moreover, a less lobulate periphery and is only occasionally slightly flattened, whereas all the specimens studied of the Albian species *Buccicrenata subgoodlandensis* are strongly compressed.

Specimens of *Buccicrenata subgoodlandensis* which the writer received through the courtesy of Dr. A. R. Loeblich reveal a simple, non-labyrinthic interior structure. The statement concerning a labyrinthic interior in the original diagnosis of *Buccicrenata* (Loeblich and Tappan, 1949, pp. 252-253) should, consequently, be rectified. The simple interior structure of *Buccicrenata* had been assumed by the writer some time ago (Maync, 1952, pp. 46, 53).

On the whole, *Buccicrenata* appears to be the lituolid genus that comes closest to *"Robulina" sogamozae* Karsten. Other genera of the Lituolinae s. str. Maync, such as *Lituola, Haplophragmium* (*fide* Bartenstein), *Phenacophragma*, or *Stomatostoecha*, either possess different apertures or show other divergent taxonomic features. It is hoped that Dr. Petters has not finished with this very interesting Colombian form, and that a restudy will lead to more conclusive results.

Because *"Robulina" sogamozae* Karsten cannot be assigned to *Choffatella*, nor to any other spirocyclinine (labyrinthic) genus of the Lituolidae, the term *"Choffatella* assemblage" (Petters, 1954) should be applied only to the levels that carry *Choffatella decipiens* Schlumberger. The occurrence of Barremian ammonite genera such as *Nicklesia, Pulchellia*, and *Karstenia* in the Rosa Blanca formation of Colombia, which is possibly equivalent to the Apón formation of western Venezuela, stratigraphically above the *Choffatella decipiens* horizon, which lies at the top of the Río Negro and the base of the Rosa Blanca formation, is of very great interest. A fauna containing the same ammonite genera was recently discovered in northern Trinidad, B.W.I. (Kugler, 1953), to which a probable lower Barremian age has been assigned (Imlay, 1954). The lowermost *Choffatella decipiens* level in Colombia is thus shown to be basal Barremian or upper Hauterivian. It is reasonable to assume the same age for the lowermost occurrence of *Choffatella decipiens* (*Choffatella* zone) in Venezuela (upper Barranquín and lower Apón formations), hitherto believed to be basal Aptian (Rod and Maync, 1954).

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Bibliography and index to new genera and species of Ostracoda for 1953

STUART A. LEVINSON
Humble Oil & Refining Company
Houston, Texas

During the year 1953, approximately sixty-three papers pertaining to ostracodes were published, including descriptions of species from the Paleozoic, Mesozoic and Cenozoic, as well as living forms. In 1953, thirty-two new genera were described. This is in contrast to fifty new genera proposed in 1952, twenty-three new genera in 1951, and thirty new genera in 1950. The stratigraphic distribution of the new genera proposed in 1953 is as follows: Paleozoic, twenty-seven; Mesozoic, one; Cenozoic, three; and Recent, none. During 1953, 240 new species were described.

The author is particularly grateful to Mrs. Betty Kellett Nadeau and Dr. Henry V. Howe for their efforts in bringing many ostracode papers to his attention. The author is further indebted to the many ostracode workers who generously supplied him with reprints of their papers and of other papers as they appeared, so that this bibliography might be as complete as possible. It is now planned to issue a bibliography and index to Ostracoda yearly, which will appear in this quarterly.

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NEW SUBGENERA, GENERA AND SUPRAGENERIC CATEGORIES IN 1953

In the alphabetically arranged list of genera, the order of the items given in each entry is as follows: Name of the genus, its author and date; name of the type species, its author and date; page and figure in the reference in which the genus is proposed; stratigraphic horizon and geographic locality of the type species (in parentheses); range and habitat of the genus; family affiliation, if noted in the paper in which the new genus is described.

Acrossula Kummerow, 1953; *A. u-scripta* Kummerow, 1953; p. 41, pl. 3, fig. 5 (Devonian, Germany); Devonian, marine, Piretellidae.

Actinocythereis Puri, 1953*b*; *Cythere exanthemata* Ulrich and Bassler, 1904; p. 178, pl. 2, figs. 4-8, tfs. e-f (Miocene, Maryland, New Jersey and Florida); Eocene to Miocene, marine.

BEYRICHIOPSIINAE Henningsmoen, 1953*a*; p. 244; subfamily erected to include the following genera: *Beyrichiopsis* Jones and Kirkby, 1886; *Deloia* Croneis and Thurman, 1938; *Leightonella* Croneis and Gale, 1938 (syn. of *Deloia* by Cooper, 1941); and *Denisonella* Croneis and Bristol, 1942).

Bolbina Henningsmoen, 1953*a*; *Bollia ornata* Krause, 1896; p. 208, tf. 7 (Ordovician, Germany); Ordovician, marine, Sigmoopsiidae.

Camdenidea Swain, 1953*a*; *C. camdenensis* Swain, 1953*a*; p. 279, pl. 39, fig. 10a-g (Lower Devonian, Tennessee); Lower Devonian, marine, Bairdiidae.

Cardiniferella Sohn, 1953; *C. bowsheri* Sohn, 1953; p. 66, tfs. 1-12 (Carboniferous, western Texas); Carboniferous, marine, Cardiniferellidae.

CARDINIFERELLIDAE Sohn, 1953; family erected to include the genus *Cardiniferella* Sohn, 1953.

Carinobolbina Henningsmoen, 1953*a*; *Ctenobolbina estona* Öpik, 1937; p. 205, tf. 4 (typographical error in figure number noted by author on reprint) (Middle Ordovician, Estonia); Middle Ordovician, marine, Sigmoopsiidae.

CONCHOPRIMITIINAE Henningsmoen, 1953*a*; p. 250, pl. 2, figs. 7-9; subfamily erected to include the following genera: *Conchoprimitia* Öpik, 1937; *Conchoides* Hessland, 1949 (syn. of *Conchoprimitia* by Henningsmoen, 1953*a*); *Conchoprimites* Hessland, 1949; ?*Ceratocypris* Poulsen, 1934; and ?*Pinnatulites* Hessland, 1949.

Ctenobolbinella Kummerow, 1953; *C. carinata* Kummerow, 1953; p. 39, pl. 4, fig. 1 (Middle Devonian, Germany); Middle Devonian, marine, Beyrichiidae.

ENTOMOCONCHACEA Sylvester-Bradley, 1953; p. 132; superfamily erected to include the families: Entomoconchidae Brady, 1868, and Cyprosinidae Whidborne, 1890, under the suborder Myodocopa.

ERIDOCONCHINAE Henningsmoen, 1953*a*; p. 255; subfamily erected to include the following genera; *Eridoconcha* Ulrich and Bassler, 1923; *Cryptophyllus* Levinson; 1951; *Milleratia* Swartz, 1936; *Schmidtella* Ulrich, 1892; and ?*Paraschmidtella* Swartz, 1936.

Gillatia Öpik, 1953; *G. trinacria* Öpik, 1953; p. 34, pl. 12, fig. 125 (Lower Silurian, Australia); Lower Silurian, marine, Beyrichiidae.

GLOSSOPSIINAE Henningsmoen, 1953*a;* p. 201; subfamily erected to include the following genera: *Glossopsis* Hessland, 1949, and *Aulacopsis* Hessland, 1949.

HEMICYTHERINAE Puri, 1953*c*; p. 172; subfamily erected to include the following genera: *Hemicythere* Sars, 1925; *Procythereis* Skogsberg, 1928; *Caudites* Coryell and Fields, 1937; *Heterocythereis* Elofson, 1941; and *Urocythere* Howe, 1951.

Hesslandella Henningsmoen, 1953*a*; *Ctenentoma macroreticulata* Hessland, 1949; p. 215, pl. 1, fig. 1 (Lower Ordovician, Sweden); Lower Ordovician, marine, Tetradellidae.

Hibbardia Kesling, 1953*b*; *Amphissites lacrimosus* Swartz and Oriel, 1948; p. 19, pl. 8, figs. 1-29; pl. 9, figs. 1-18 (Middle Devonian, New York); Middle Devonian, marine, Beyrichiidae.

Kayatia Öpik, 1953; *K. prima* Öpik, 1953; p. 32, pl. 11, figs. 104-109, tf. 12a-b (Lower Silurian, Australia); Lower Silurian, marine.

Leptoprimitia Kummerow, 1953; *L. compressa* Kummerow, 1953; p. 31, pl. 4, figs. 5-6 (Devonian, Poland); Devonian, marine, Primitiidae.

Limnoprimitia Kummerow, 1950; described again as a new genus (Kummerow, 1953, p. 15) with same description and type species.

Neobeyrichiopsis Tasch, 1953; *N. emporiensis* Tasch, 1953; p. 401, pl. 49, figs. 18-19 (Pennsylvanian, Kansas); Pennsylvanian, marine.

Omphalentomis Kummerow, 1953; *Primitia splendens* (Matern 1939); p. 62, pl. 2, fig. 2 (Upper Devonian, Germany); Devonian, marine, Entomidae.

Orthocypris Kummerow, 1953; *Bythocypris recta* Kummerow, 1943; p. 54 (Middle Silurian, Germany); Middle Silurian to Devonian, marine, Bairdiidae.

PALEOCOPA Henningsmoen, 1953*a*; p. 188; suborder erected to include the superfamilies Beyrichiacea and Leperditiacea.

Phlyctiscapha Kesling, 1953*a*; *P. rockportensis* Kesling, 1953; p. 222, tf. 1; pl. 1, figs. 1-20; pl. 2, figs. 1-19 (Middle Devonian, Michigan); Middle Devonian, marine, Beyrichiidae.

Piretopsis Henningsmoen, 1953*b*; *P. donsi* Henningsmoen, 1953; p. 43, pl. 1, fig. 7; pl. 2, figs. 7-8 (Middle Ordovician, Norway); Middle Ordovician, marine, Tetradellidae, Piretellinae.

Platybolbina Henningsmoen, 1953*b*; *Primitia distans* Krause, 1889; p. 50 (Upper Ordovician; Scando-Baltic region); Ordovician, marine, Eurychilinidae, Eurychilininae. (Syn.: *Platychilina* Kummerow, 1933 *(nomen nudum)*, and *Platychilina* Kummerow of Thorslund, 1940; non *Platychilina* Koken, 1892, a gastropod.) This genus may or may not be the same as *Platychilina* Kummerow, 1939 (type: *Primitia elongata* Krause, 1891).

Quadricollina Öpik, 1953; *Q. initialis* Öpik, 1953; p. 30, pl. 11, figs. 98-99 (Lower Silurian, Australia); Lower Silurian, marine, Drepanellidae ("only a single specimen is known as yet").

QUADRIJUGATIDAE Kesling and Hussey, 1953; family erected to include the genera: *Quadrijugator* Kesling and Hussey, 1953; *Ceratopsis* Ulrich, 1894; *Glossopsis* Hessland, 1949; *Ogmoopsis* Hessland, 1949; and nondimorphic European species at present assigned to *Tetradella,* such as *T. grewingki* (Bock) and *T. lanceolata* Hessland. Range Lower to Upper Ordovician.

Quadrijugator Kesling and Hussey, 1953; *Bollia permarginata* Foerste, 1917; p. 82 (Upper Ordovician, Ohio and Michigan); Upper Ordovician, marine, Quadrijugatidae.

Reticestus Kesling and Weiss, 1953; *R. acclivitatus* Kesling and Weiss, 1953; p. 53, pl. 3, fig. 36 (Middle Devonian, Michigan); Middle Devonian, marine, Kirkbyidae.

Ruptivelum Kesling and Weiss, 1953; *R. bacculatum* Kesling and Weiss, 1953; p. 47, pl. 1, figs. 22-30 (Middle Devonian, Michigan); Middle Devonian, marine, Hollinidae.

Sigmobolbina Henningsmoen, 1953*a*; *Entomis oblonga* Steusloff var. *kuckersiana* Bonnema, 1909; p. 206, tf. 6 (Middle Ordovician, Estonia); Middle Ordovician, marine, Sigmoopsiidae.

SIGMOOPSIIDAE Henningsmoen, 1953*a;* p. 201; family erected to include the subfamilies Glossopsiinae Henningsmoen, 1953, and Sigmoopsiinae Henningsmoen, 1953. (See subfamilies for list of genera included.)

SIGMOOPSIINAE Henningsmoen, 1953*a*; p. 203; subfamily erected to include the following genera: *Ogmoopsis* Hessland, 1949; *Sigmoopsis* Henningsmoen, 1953; *Sigmobolbina* Henningsmoen, 1953; *Carinobolbina* Henningsmoen, 1953; *Bolbina* Henningsmoen, 1953; ?*Kiesowia* Ulrich and Bassler, 1908; ?*Ctenobolbina* Ulrich, 1890; and ?*Winchellatia* Kay, 1940.

Sigmoopsis Henningsmoen, 1953*a*; *Ceratopsis platyceras* Öpik, 1937; p. 204, tf. 5 (typographical error in figure number noted by author on reprint) (Middle Ordovician, Estonia); Middle Ordovician, marine, Sigmoopsiidae.

Sigynus Kesling, 1953*e*; *S. dictyotus* Kesling, 1953*e*; p. 4, pl. 1, figs. 10-12 (Middle Devonian, Ontario, Canada); Middle Devonian, marine, Aechminidae.

Tetrastorthynx Kesling, 1953*c*; *T. diabolicus* Kesling, 1953*c*; p. 195, pl. 1, figs. 7-10 (Middle Devonian, Ontario, Canada); Middle Devonian, marine, Drepanellidae.

Thlipsurina Kummerow, 1953 (non Bassler, 1941); *Thlipsura tetragona* Krause; p. 49; Middle Silurian to Devonian, Germany, Thlipsuridae.

Tmemolophus Kesling, 1953*c*; *T. margarotus* Kesling, 1953*c*; p. 194, pl. 1, figs. 1-6 (Middle Devonian, Ontario, Canada); Middle Devonian, marine, Drepanellidae.

Toulminia Munsey, 1953; *T. hyalokystis* Munsey, 1953; p. 6, pl. 2, figs. 26-27, tf. 1 (Paleocene, Alabama); Paleocene, marine, Cytheridae, Cytherinae.

Trachyleberidea Bowen, 1953; *Cythereis prestwichiana* Jones and Sherborn, 1887; p. 285, tf. A (6a-d) (Eocene, British Isles); Eocene, marine, Trachyleberidae, Trachyleberinae.

Xystinotus Kesling, 1953*c*; *X. wrightorum* Kesling, 1953*c*; p. 197, pl. 1, figs. 17-21 (Middle Devonian, Ontario, Canada); Middle Devonian, marine, Drepanellidae.

NEW SPECIES, SUBSPECIES AND VARIETIES IN 1953

Acratia fusiformis Kummerow, 1953; p. 57, pl. 7, fig. 11a-b (Middle Devonian, Germany); Bairdiidae.

Acratia wolhynica Kummerow, 1953; p. 57, pl. 6, fig. 10a-b (Middle Devonian, Poland); Bairdiidae.

Acrossula rugosa Kummerow, 1953; p. 42, pl. 3, fig. 4 (Middle Devonian, Germany); Piretellidae.

Acrossula u-scripta Kummerow, 1953; p. 42, pl. 3, fig. 5 (Middle Devonian, Tattenberg, Blankenheim, Germany); Piretellidae.

Aechmina aechmessa Öpik, 1953; p. 29, pl. 11, figs. 93-94 (Lower Silurian, Australia).

Aechmina phantastica Kesling, 1953*e*; p. 3, pl. 1, figs. 1-5 (Middle Devonian, Ontario, Canada); Aechminidae.

Aechminaria hormathota Kesling, 1953*e*; p. 5, pl. 1, figs. 21-22, 24-29 (Middle Devonian, Ontario, Canada); Aechminidae.

Amphissites correnst Kummerow, 1953; p. 48, pl. 2, fig. 8 (Upper Devonian, Weitershausen, Buchenau, Germany); Kirkbyidae.

Amphissites decoratus Kummerow, 1953; p. 46, pl. 2, fig. 9a-b (Middle Devonian, Poland); Kirkbyidae.

Amphissites deltoideus Kummerow, 1953; p. 47, pl. 5, fig. 2a-b (Middle Devonian, Germany); Kirkbyidae.

Amphissites inornatus Kummerow, 1953; p. 47, pl. 2, fig. 10a-b (Middle Devonian, Poland); Kirkbyidae.

Aparchites devonicus Kummerow, 1953; p. 25, pl. 5, fig. 4a-b (Middle Devonian, Germany); Leperditellidae.

Aparchites? pentagonalis Kummerow, 1953; p. 25, pl. 5, fig. 5a-b (Middle Devonian, Dombrowa, Poland); Leperditellidae.

Arcyzona aperticarinata Kesling and Weiss, 1953; p. 51, pl. 3, figs. 42-49 (Middle Devonian, Michigan); Kirkbyidae.

Bairdia calceolae Kummerow, 1953; p. 51, pl. 5, fig 7a-b (Middle to Upper Devonian, Germany); Bairdiidae.

Bairdia ceramensis Key, 1953; p. 157, pl. 1, figs. 2a-b, 3 (Recent, marine, Indonesia).

Bairdia eifliensis Kummerow, 1953; p. 51, pl. 5, fig. 9a-b (Middle Devonian, Germany); Bairdiidae.

Bairdia paffrathensis Kummerow, 1953; p. 52, pl. 5, fig. 10a-b (Middle Devonian, Germany); Bairdiidae.

Bairdia tantilla Kummerow, 1953; p. 52, pl. 5, fig. 8a-b (Middle Devonian, Poland); Bairdiidae.

Bairdiacypris? rotundata Kummerow, 1953; p. 17, pl. 1, fig. 11a-b (Upper Carboniferous, well no. 201, near Grodziec, Poland, at 171.40-171.50 meters); Bairdiidae.

Beyrichia epona Öpik, 1953; p. 33, pls. 11 and 12, figs. 111-119 (Lower Silurian, Australia).

Beyrichia favaria Kummerow, 1953; p. 36, pl. 3, fig. 12 (Lower Devonian, Heimbach, Hasenfelde, Germany); Beyrichiidae.

Beyrichia fossulata Kummerow, 1953; p. 34, pl. 3, fig. 9 (Middle Devonian, Germany); Beyrichiidae.

Beyrichia foveatula Kummerow, 1953; p. 37, pl. 3, fig. 13 (Middle Devonian, Germany); Beyrichiidae.

Beyrichia mamillata Kummerow, 1953; p. 36, pl. 3, fig. 11a-b (Lower Devonian, Germany); Beyrichiidae.

Beyrichia rugulosa Kummerow, 1953; p. 37, pl. 3, fig. 14a-b (Middle Devonian, Germany); Beyrichiidae.

Beyrichia semicircularis Kummerow, 1953; p. 35, pl. 3, fig. 10 (Middle Devonian, Germany); Beyrichiidae.

Beyrichia? thuringica Kummerow, 1953; p. 38, pl. 3, fig. 15 (Lower Devonian, Germany); Beyrichiidae.

Bollia ungulata Bassler var. *bassleri* Swain, 1953*a;* p. 268, pl. 37, fig. 6a-e (Lower Devonian, Tennessee); Drepanellidae.

Bollia ungulata Bassler var. *depressa* Swain, 1953*a;* p. 268, pl. 37, fig. 8a-f (Lower Devonian, Tennessee); Drepanellidae.

Bollia u-scripta Kummerow, 1953; p. 31, pl. 2, fig. 20 (Upper Devonian, Weitershausen, Buchenau, Germany); Primitiidae.

Burlella curvata Kummerow, 1953; p. 19, pl. 1, fig. 13 (Upper Carboniferous, well no. 201, near Grodziec, Poland, at 71.00 meters); Bairdiidae.

Burlella exigua Kummerow, 1953; p. 18, pl. 1, fig. 12a-b (Upper Carboniferous, well no. 201, near Grodziec, Poland, at 69.20-71.60 meters); Bairdiidae.

Bythocypris exigua Kummerow, 1953; p. 16, pl. 1, fig. 8a-b (Upper Carboniferous, well no. 201, near Grodziec, Poland, at 70.00-71.40 and at 172.20 meters); Bairdiidae.

Bythocypris gibbosa Kummerow, 1953; p. 16, pl. 1, fig. 9a-b (Carboniferous, quarry south of Rybnik, Poland); Bairdiidae.

Bythocypris hercynica Kummerow, 1953; p. 52, pl. 2, fig. 1a-b (Lower Devonian, Germany); Bairdiidae.

Bythocypris? longissima Kummerow, 1953; p. 53, pl. 6, fig. 3a-b (Middle Devonian, Germany); Bairdiidae.

Bythocypris tenella Kummerow, 1953; p. 17, pl. 1, fig. 10a-b (Upper Carboniferous, Poland); Bairdiidae.

Bythocythere kueneni Key, 1953; p. 163, pl. 2, figs. 1a-c, 2a-b (Recent, marine, Indonesia).

Camdenidea camdenensis Swain, 1953*a;* p. 280, pl. 39, fig. 10a-g (Lower Devonian, Tennessee); Bairdiidae.

Candona acutimarginata Lankford, 1953; p. 102, pl. 13, fig. 1 (Upper Cretaceous, Utah); Cypridae.

Candona dichtliae Brehm, 1953*c*; pp. 21-22 (Recent, Austria).

Candona ruttneri Brehm, 1953*a*; p. 12, tfs. 5-8 (Recent, Austria).

Carbonita minima Kummerow, 1953; p. 21, pl. 1, fig. 16a-b (Upper Carboniferous, Gliwice, Poland); Cytherellidae.

Carbonita ovata Kummerow, 1953; p. 21, pl. 1, fig. 17a-b (Upper Carboniferous, Gliwice, Poland); Cytherellidae.

Cardiniferella bowsheri Sohn, 1953; p. 66, tfs. 1-12 (Carboniferous, western Texas); Cardiniferellidae.

Caudites chipolensis Puri, 1953*c;* p. 177, pl. 2, figs. 7-8 (Miocene, Florida); Cytheridae, Hemicytherinae.

Cavellina dentata Kummerow, 1953; p. 59, pl. 7, fig. 3a-b (Middle Devonian, Poland); Cytherellidae.

Cavellina elongata Kummerow, 1953; p. 57, pl. 6, fig. 11a-b (Middle Devonian, Poland); Cytherellidae.

Cavellina macella Kummerow, 1953; p. 58, pl. 7, fig. 1a-b (Middle Devonian, Germany); Cytherellidae.

Cavellina phaseolus Kummerow, 1953; p. 59, pl. 7, fig. 2a-b (Middle Devonian, Germany); Cytherellidae.

Cavellina rugata Kummerow, 1953; p. 58, pl. 2, fig. 4 (Middle Devonian, Germany); Cytherellidae.

Ceratopsis devonicus Kummerow, 1953; p. 39, pl. 3, fig. 18a-b (Middle Devonian, Germany); Beyrichiidae.

Ceratopsis? stoermeri Henningsmoen, 1953*b*; p. 42, pl. 1, fig. 6; pl. 2, fig. 6 (Middle Ordovician, Norway); Tetradellidae.

Clithrocytheridea diagonalis Malkin, 1953*a;* p. 782, pl. 79, figs. 18-19, 21-22, 24 (Middle Miocene, Maryland).

Clithrocytheridea macrolaccus Munsey, 1953; p. 15, pl. 3, figs. 1-3 (Paleocene, Alabama); Cytheridae, Cytherideinae.

Clithrocytheridea virginiensis Malkin, 1953*a;* p. 783, pl. 79, figs. 23, 25-28 (Upper Miocene, Virginia).

Conchoecia skogsbergi Iles, 1953; p. 264 (Recent, marine, southwest Africa).

Conchoecia teretivalvata Iles, 1953; p. 265, tfs. 2-3 (Recent, marine, southwest Africa).

Cornigella immotipedeta Kesling, 1953*c;* p. 200, pl. 1, figs. 33-45 (Middle Devonian, Ontario, Canada); Drepanellidae.

Cryptocandona juvavi Brehm, 1953*a*; p. 10, tfs. 1-4 (Recent, Austria).

Ctenentoma? dubitabilis Öpik, 1953; p. 34, pl. 12, figs. 120-123 (Lower Silurian, Australia); Hollinidae, Ctenentominae.

Ctenentoma? unguiculata Öpik, 1953; p. 34, pl. 12, fig. 124, tf. 13 (Lower Silurian, Australia); Hollinidae, Ctenentominae.

Ctenobolbina proxima Öpik, 1953; p. 32, pl. 11, fig. 102, tf. 11c (Lower Silurian, Australia).

Ctenobolbinella carinata Kummerow, 1953; p. 40, pl. 4, fig. 1 (Middle Devonian, Germany); Beyrichiidae.

Ctenoloculina acanthina Kesling, 1953*d;* p. 206, pl. 2, figs. 1-13 (Middle Devonian, Ontario, Canada); Hollinidae.

Ctenoloculina platyzanclota Kesling, 1953*d;* p. 208, pl. 2, figs. 20-24 (Middle Devonian, Ontario, Canada); Hollinidae.

Ctenoloculina thliberilobota Kesling, 1953*d*; p. 204, pl. 1, figs. 4-13; pl. 2, figs. 14-16 (Middle Devonian, Ontario, Canada); Hollinidae.

Cyprideis? glabra Goerlich, 1953; p. 129, pl. 1, figs. 4-5 (Oligocene, Bavaria); Cytheridae, Cytherideinae.

Cyprideis polita ornata Steghaus, 1953; p. 42, pl. 2B, figs. 1-4 (Jurassic, Germany); Cytheridae, Cytherideinae.

Cyprideis? rara Goerlich, 1953; p. 130, pl. 1, figs. 1-3 (Oligocene, Bavaria); Cytheridae, Cytherideinae.

Cythere denticulata Lankford, 1953; p. 96, pl. 15, fig. 6 (Upper Cretaceous, Utah); Cytheridae.

Cythereis abrarmus Munsey, 1953; p. 10, pl. 4, fig. 21 (Paleocene, Alabama); Cytheridae, Trachyleberinae.

Cythereis coalvillensis Lankford, 1953; p. 97, pl. 16, fig. 1 (Upper Cretaceous, Utah); Cytheridae.

Cythereis dictyolobus Munsey, 1953; p. 9, pl. 4, figs. 9-11 (Paleocene, Alabama); Cytheridae, Trachyleberinae.

Cytherella transversalis Kummerow, 1953; p. 19, pl. 1, fig. 14a-b (Upper Carboniferous, well no. 201, near Grodziec, Poland, at 71.00-71.60 and at 170.80-172.50 meters); Cytherellidae.

Cytherelloidea erronecostata Munsey, 1953; p. 3, pl. 1, figs. 12-13 (Paleocene, Alabama); Cytherellidae.

Cytherelloidea nanopleura Munsey, 1953; p. 4, pl. 1, fig. 5 (Paleocene, Alabama); Cytherellidae.

Cytherelloidea triebeli Munsey, 1953; p. 3, pl. 1, fig. 6 (Paleocene, Alabama); Cytherellidae.

Cytheridea (Cytheridea) bavarica Goerlich, 1953; p. 133, pl. 3, fig. 26; pl. 4, fig. 27-29 (Oligocene, Bavaria); Cytheridae, Cytherideinae.

Cytheridea (Cytheridea) eggeri Goerlich, 1953; p. 134, pl. 4, figs. 30-35 (Burdigalian (Miocene), Bavaria); Cytheridae, Cytherideinae.

Cytheridea (Cytheridea) leingartensis Goerlich, 1953; p. 135, pl. 2, figs. 16-18; pl. 3, figs. 20-25 (Helvetian (Miocene), Bavaria); Cytheridae, Cytherideinae.

Cytheridea (Cytheridea) müllerii subsp. *truncatula* Goerlich, 1953; p. 131, pl. 1, fig. 6 (Chattian (Oligocene), Bavaria); Cytheridae, Cytherideinae.

Cytheridea posterovata Lankford, 1953, p. 99, pl. 15, fig. 3 (Upper Cretaceous, Utah); Cytheridae.

Cytheridea posterovata var. *allta* Lankford, 1953; p. 100, pl. 15, fig. 4 (Upper Cretaceous, Utah); Cytheridae.

Cytheridea (Eucytheridea) reticulata Goerlich, 1953; p. 137, pl. 5, figs. 40-42 (Rupelian (Oliogocene), Bavaria); Cytheridae, Cytherideinae.

Cytheridea trisulcata Lankford, 1953; p. 99, pl. 15, fig. 5 (Upper Cretaceous, Utah); Cytheridae.

Cytheridea (Cytheridea) ventricosa Goerlich, 1953; p. 136, pl. 4, figs. 36-37; pl. 5, figs. 36-39 (Rupelian (Oligocene), Bavaria); Cytheridae, Cytherideinae.

Cytherideis caledoniensis Munsey, 1953; p. 13, pl. 3, fig. 5 (Paleocene, Alabama); Cytheridae.

Cytherideis echolsae Malkin, 1953*a*; p. 778, pl. 78, figs. 14-17 (Upper Miocene, Virginia).

Cytheropteron (Cytheropteron) brimptoni Bowen, 1953; p. 280, tf. A(7a-c) (Eocene, British Isles); Cytheridae, Loxoconchinae.

Cytheropteron (Cytheropteron) hincheyi Munsey, 1953; p. 16, pl. 2, figs. 3-7 (Paleocene, Alabama); Cytheridae, Loxoconchinae.

Cytheropteron (Cytheropteron) liogluma Munsey, 1953; p. 17, pl. 3, fig. 22 (Paleocene, Alabama); Cytheridae, Loxoconchinae.

Cytheropteron (Eocytheropteron) sherborni Bowen, 1953; p. 281, tf. A(5a-b) (Eocene, British Isles); Cytheridae, Loxoconchinae.

Cytherura boldi Munsey, 1953; p. 18, pl. 2, fig. 19 (Paleocene, Alabama); Cytheridae, Cytherurinae.

Cytherura coryelli Malkin, 1953*a*; p. 788, pl. 80, figs. 20-21, 25 (Middle Miocene, Maryland).

Cytherura dorilaemus Munsey, 1953; p. 17, pl. 3, fig. 7 (Paleocene, Alabama); Cytheridae, Cytherurinae.

Cytherura oxycruris Munsey, 1953; p. 18, pl. 1, figs. 22-23 (Paleocene, Alabama); Cytheridae, Cytherurinae.

Cytherura phaseolus Munsey, 1953; p. 18, pl. 3, fig. 8 (Paleocene, Alabama); Cytheridae, Cytherurinae.

Darwinula protracta Rome, 1953; p. 39, pl. 2, figs. 16-25 (Recent, Belgian Congo, Africa); Darwinulidae.

Dilobella? chapmani Öpik, 1953; p. 32, pl. 11, fig. 103; tf. 11d (Lower Silurian, Australia).

Dizygopleura clariformis Kummerow, 1953; p. 44, pl. 4, fig. 10a-b (Middle Devonian, Germany); Kloedenellidae.

Dizygopleura concentrica Kummerow, 1953; p. 43, pl. 4, fig. 9 (Lower Devonian, Ehrenbreitstein, Germany); Kloedenellidae.

Dizygopleura cuneata Kummerow, 1953; p. 45, pl. 4, fig. 12a-b (Middle Devonian, Germany); Kloedenellidae.

Dizygopleura elongata Kummerow, 1953; p. 44, pl. 4, fig. 11a-b (Middle Devonian, Poland); Kloedenellidae.

Drepanellina? rudis Kummerow, 1953; p. 34, pl. 3, fig. 8 (Upper Devonian, near Ratingen-Ost, Germany); Zygobolbidae.

Drepanellina victoriana Öpik, 1953; p. 35, pl. 12, figs. 128-129 (Lower Silurian, Australia).

Entomis (Entomis) gigantea Kummerow, 1953; p. 62, pl. 7, fig. 7 (Upper Devonian, Novaruda, Sudeten); Entomidae.

Eocytheropteron yorktownensis Malkin, 1953*a*; p. 780, pl. 79, figs. 1-4 (Upper Miocene, Virginia).

Eoleperditia skjesethi Henningsmoen, 1953*b*; p. 52, pl. 1, fig. 17; pl. 5, fig. 1 (Middle Ordovician, Norway); Leperditiidae.

Euglyphella simplex Kesling and Weiss, 1953; p. 58, pl. 4, figs. 8-11 (Middle Devonian, Michigan); Thlipsuridae.

Eukloedenella cuneata Kummerow, 1953; p. 43, pl. 4, fig. 8a-b (Middle to Upper Devonian, Germany); Kloedenellidae.

Euprimitia plana Kummerow, 1953; p. 29, pl. 2, fig. 16a-c (Middle Devonian, Germany); Primitiidae.

Falsipollex bulbosus Kesling and Tabor, 1953; p. 93, pl. 2, figs. 11-17 (Middle Devonian, Michigan); Hollinidae.

Falsipollex equipapillatus Kesling and Weiss, 1953; p. 44, pl. 1, figs. 1-13 (Middle Devonian, Michigan); Hollinidae.

Falsipollex minimus Kesling and Tabor, 1953; p. 92, pl. 2, figs. 5-10 (Middle Devonian, Michigan); Hollinidae.

Gillatia limata Öpik, 1953; p. 35, pl. 12, fig. 126; tf. 14a (Lower Silurian, Australia); Beyrichiidae.

Gillatia? mitis Öpik, 1953; p. 35, pl. 12, fig. 127 (Lower Silurian, Australia); Beyrichiidae.

Gillatia trinacria Öpik, 1953; p. 34, pl. 12, fig. 125 (Lower Silurian, Australia); Beyrichiidae.

Glyptopleura bipunctata Kesling and Weiss, 1953; p. 54, pl. 3, figs. 27-29 (Middle Devonian, Michigan); Glyptopleuridae.

Halliella hercynica Kummerow, 1953; p. 30, pl. 3, fig. 3 (Middle Devonian, Glockenberg, Clausthal-Zellerfeld, Germany); Primitiidae.

Halliella rhenana Kummerow, 1953; p. 30, pl. 3, fig. 2 (Middle Devonian, Germany); Primitiidae.

Haplocytheridea dacica subsp. *elegantior* Goerlich, 1953; p. 139, pl. 6, figs. 50-51 (Helvetian (Miocene), Bavaria); Cytheridae, Cytherideinae.

Healdia gibba Kesling and Weiss, 1953; p. 56, pl. 5, figs. 9-10, 12 (Middle Devonian, Michigan); Healdiidae.

Hemicythere howei Puri, 1953*c*; p. 176, pl. 1, figs. 7-9 (Miocene, Florida); Cytheridae, Hemicytherinae.

Hemicythere schmidtae Malkin, 1953*a*; p. 796, pl. 82, figs. 19-23 (Upper Miocene, Virginia).

Hemicytherura defiorei Ruggieri, 1953*b*; p. 50, tfs. 8, 8a, 11-13 (Middle Miocene, Piemonte, Italy).

Hemicytherura videns subsp. *gracilicosta* Ruggieri, 1953*b*; p. 50, tfs. 5, 5a-b, 7 (Pliocene to Pleistocene, Toscana, Italy).

Hollinella ampla Kesling and Weiss, 1953; p. 38, pl. 2, fig. 27 (Middle Devonian, Michigan); Hollinidae.

Hollinella amplilobata Kesling and Tabor, 1953; p. 84, pl. 1, figs. 9-17 (Middle Devonian, Michigan); Hollinidae.

Hollinella cuspibulbata Kesling and Tabor, 1953; p. 85, pl. 2, figs. 1-4 (Middle Devonian, Michigan); Hollinidae.

Hollinella debilis Kummerow, 1953; p. 41, pl. 4, fig. 4 (Middle Devonian, Germany); Beyrichiidae.

Hollinella dissimilis Tasch, 1953; p. 399, pl. 49, figs. 35-36 (Pennsylvanian, Kansas).

Hollinella hamata Kummerow, 1953; p. 40, pl. 4, fig. 2a-b (Middle Devonian, Poland); Beyrichiidae.

Hollinella inclinisulcata Kesling and Weiss, 1953; p. 40, pl. 2, figs. 5-8 (Middle Devonian, Michigan); Hollinidae.

Hollinella labrosa Kesling and Weiss, 1953; p. 35, pl. 2, figs. 1-4 (Middle Devonian, Michigan); Hollinidae.

Hollinella mamillata Kummerow, 1953; p. 40, pl. 4, fig. 3a-b (Middle Devonian, Germany); Beyrichiidae.

Hollinella plauta Kesling and Tabor, 1953; p. 86, pl. 1, figs. 18-22 (Middle Devonian, Michigan); Hollinidae.

Hollinella senticosa Kesling, 1953*d*; p. 211, pl. 3, figs. 22-23 (Middle Devonian, Ontario, Canada); Hollinidae.

Hollinella tendilobata Kesling and Weiss, 1953; p. 39, pl. 2, figs. 23-26 (Middle Devonian, Michigan); Hollinidae.

Hollinella vegrandis Kesling and Tabor, 1953; p. 84, pl. 1, figs. 23-27 (Middle Devonian, Michigan); Hollinidae.

Jenningsina scalpta Kesling and Weiss, 1953; p. 63, pl. 4, figs. 42-43 (Middle Devonian, Michigan); Quasillitidae.

Jonesina polonica Kummerow, 1953; p. 45, pl. 4, fig. 13a-b (Middle Devonian, Poland); Kloedenellidae.

Jonesina silesiaca Kummerow, 1953; p. 14, pl. 1, fig. 6a-b (Upper Carboniferous, well no. 201, near Grodziec, Poland, at 171.80 and at 172.40-172.50 meters); Beyrichiidae.

Kangarina abyssicola subsp. *coarctata* Ruggieri, 1953*b*; p. 53, tf. 16, 16a (Middle Miocene, Piemonte, Italy).

Kayatia multicarinata Öpik, 1953; p. 33, pl. 11, fig. 110; tf. 12c-d (Lower Silurian, Australia).

Kayatia prima Öpik, 1953; p. 32, pl. 11, figs. 104-109; tf. 12a-b (Lower Silurian, Australia).

Kellettina nebeni Kummerow, 1953; p. 12, pl. 1, fig. 4a-b (Upper Carboniferous, quarry near Bytom, Poland; well no. 201, near Grodziec, Poland, at 185.90 meters); Primitiidae.

Kiesowia peregrina Öpik, 1953; p. 31, pl. 11, figs. 100-101, tf. 11b (Lower Silurian, Australia).

Kirkbya nodosa Kummerow, 1953; p. 46, pl. 3, fig. 1 (Middle Devonian, Germany); Kirkbyidae.

Kloedenia onusta Kummerow, 1953; p. 33, pl. 3, fig. 6 (Lower Devonian, Germany); Zygobolbidae.

Kloedenia thuringica Kummerow, 1953; p. 33, pl. 3, fig. 7 (Lower Devonian, Saalfeld, Germany); Zygobolbidae.

Krithe droogeri Key, 1953; p. 159, pl. 1, figs. 6a-b, 7 (Recent, marine, Indonesia).

Leguminocythereis parallelokladia Munsey, 1953; p. 12, pl. 2, figs. 1-2 (Paleocene, Alabama); Cytheridae.

Leperditella bucculenta Kummerow, 1953; p. 23, pl. 7, fig. 4 (Middle Devonian, Germany); Leperditellidae.

Leptoprimitia circumvallata Kummerow, 1953; p. 32, pl. 4, fig. 7a-c (Middle Devonian, Poland); Primitiidae.

Leptoprimitia compressa Kummerow, 1953; p. 31, pl. 4, figs. 5-6 (Middle Devonian, Poland); Primitiidae.

Limnocythere conifera Brehm, 1953*b;* p. 70, tf. 9 (Recent, Tasmania).

Loxoconcha alata Brady var. *longispina* Key, 1953; p. 160, pl. 1, fig. 10a-b (Recent, marine, Indonesia).

Loxoconcha notoaulax Munsey, 1953; p. 16, pl. 3, figs. 9-10 (Paleocene, Alabama); Cytheridae, Loxoconchinae.

Macrocypris? silesiaca Kummerow, 1953, p. 20, pl. 1, fig. 15a-b (Upper Carboniferous, Gliwice, Poland); Cytherellidae.

Macronotella? semicircularis Kummerow, 1953; p. 48, pl. 5, fig. 3a-b (Middle Devonian, Gondelsheim, Germany); Kirkbyidae.

Mesocypris terrestris Harding, 1953; p. 361, tfs. 1-17 (Recent, Union of South Africa).

Microcheilinella amaliae Kummerow, 1953; p. 59, pl. 7, fig. 5a-b (Middle Devonian, Germany); Cytherellidae.

Microcheilinella ovata Kummerow, 1953; p. 61, pl. 7, fig. 6a-b (Lower Devonian, Germany); Cytherellidae.

Microcheilinella seminalis Kummerow, 1953; p. 60, pl. 2, fig. 11a-b (Middle Devonian, Germany); Cytherellidae.

Microxestoleberis westmorelandi Munsey, 1953; p. 19, pl. 1, figs. 14-15 (Paleocene, Alabama); Cytheridae, Xestoleberinae.

Moorea circumvallata Kummerow, 1953; p. 49, pl. 1, fig. 7a-c (horizon unknown, western Germany); Youngiellidae.

Monoceratina biphysa Munsey, 1953; p. 17, pl. 3, fig. 23 (Paleocene, Alabama); Cytheridae, Bythocytherinae.

Monoceratina cooperi Swain, 1953*a*; p. 283, pl. 39, fig. 11a-b (Lower Devonian, Tennessee); family uncertain.

Neobeyrichiopsis emporiensis Tasch, 1953; p. 401, pl. 49, figs. 18-19 (Pennsylvanian, Kansas).

Orthocypris dubia Kummerow, 1953; p. 56, pl. 6, fig. 8a-b (Middle Devonian, Germany); Bairdiidae.

Orthocypris obliqua Kummerow, 1953; p. 55, pl. 6, fig. 6a-b (Middle Devonian, Germany); Bairdiidae.

Orthocypris perlonga Kummerow, 1953; p. 55, pl. 6, fig. 7a-b (Middle Devonian, Germany); Bairdiidae.

Pachydomella dorsoclefta Swain, 1953*a*; p. 281, pl. 39, fig. 4a-c; tfs. 17-18 (Lower Devonian, Tennessee); family uncertain.

Pachydomella thlipsuroidea Swain, 1953*a*; p. 280, pl. 38, fig. 13; pl. 39, fig. 3a-c (Lower Devonian, Tennessee); family uncertain.

Paijenborchella (Neomonoceratina) mediterranea Ruggieri, 1953*a*; reprint p. 4, tfs. 1-5 (Recent, Port Said).

Parabolbina acinina Kesling and Weiss, 1953; p. 43, pl. 2, figs. 21-22 (Middle Devonian, Michigan); Hollinidae.

Parabolbina hypercala Kesling and Tabor, 1953; p. 88, pl. 3, figs. 1-7 (Middle Devonian, Michigan); Hollinidae.

Parabolbina oxypages Kesling and Tabor, 1953; p. 89, pl. 3, figs. 8-15 (Middle Devonian); Hollinidae.

Paracyprideis punctata Goerlich, 1953; p. 145, pl. 9, figs. 80-82 (Rupelian (Oligocene), Bavaria); Cytheridae, Cytherideinae.

Paracyprideis triebeli Goerlich, 1953; p. 144, pl. 9, figs. 74-79; pl. 8, fig. 71 (Helvetian (Miocene), Bavaria); Cytheridae, Cytherideinae.

Paracytheridea shattucki subsp. *curta* Malkin, 1953*a;* p. 781, pl. 79, figs. 10-12 (Upper Miocene, Virginia).

Paracytheridea similis Malkin, 1953*a*; p. 781, pl. 79, figs. 13-14 (Upper Miocene, Virginia).

Paraparchites bucerus Kummerow, 1953; p. 11, pl. 1, fig. 2 (Upper Carboniferous, well no. 201, near Grodziec, Poland, at 172.20 meters); Leperditellidae.

Paraparchites crumena Kummerow, 1953; p. 27, pl. 5, fig. 1a-b (Middle to Upper Devonian, Germany); Leperditellidae.

Paraparchites symmetricus Kummerow, 1953; p. 11, pl. 1, fig. 3a-b (Upper Carboniferous, near Bytom (Beuthen), Poland); Leperditellidae.

Pelocypris zilchi Triebel, 1953*a*; p. 2, pl. 1, figs. 1-8 (Pleistocene, El Salvador); Cypridae, Cyprinae.

Phlyctiscapha rockportensis Kesling, 1953*a*; p. 222, tf. 1; pl. 1, figs. 1-20; pl. 2, figs. 1-19 (Middle Devonian, Michigan); Beyrichiidae.

Piretopsis donsi Henningsmoen, 1953*b*; p. 44, pl. 1, fig. 7; pl. 2, figs. 7-8 (Middle Ordovician, Norway); Tetradellidae.

Platella kellettae Munsey, 1953; p. 5, pl. 1, fig. 4 (Paleocene, Alabama); Cytherellidae.

Poloniella tertia Krommelbein, 1953; p. 58, pl. 3, fig. 3a-d (Middle Devonian, Germany).

Polyzygia geesensis Krommelbein, 1953; p. 56, pl. 3, fig. 2a-d (Middle Devonian, Germany).

Polyzygia gürichi Krommelbein, 1953; p. 54, pl. 3, fig. 1a-d (Middle Devonian, Germany).

Primitia fulgens Kummerow, 1953; p. 28, pl. 2, fig. 18 (Middle Devonian, Germany); Primitiidae.

Primitiella? nuculiforma Swain, 1953*a*; p. 264, pl. 37, fig. 2a-b (Lower Devonian, Tennessee); Primitiidae.

Primitiella? ovata Kummerow, 1953; p. 27, pl. 2, fig. 15a-b (Middle Devonian, Germany); Primitiidae.

Primitiopsis eifliensis Kummerow, 1953; p. 29, pl. 2, fig. 19a-c (Middle Devonian, Germany); Primitiidae.

Punctoprimitia natalis Öpik, 1953; p. 29, pl. 11, fig. 95; tf. 10 (Lower Silurian, Australia).

Quadricollina initialis Öpik, 1953; p. 30, pl. 11, figs. 98-99 (Lower Silurian, Australia); Drepanellidae.

Quasillites jubatus Kesling and Weiss, 1953; p. 61, pl. 4, figs. 17-21 (Middle Devonian, Michigan); Quasillitidae.

Reticestus acclivitatus Kesling and Weiss, 1953; p. 53, pl. 3, fig. 36 (Middle Devonian, Michigan); Kirkbyidae.

Ropolonellus plenus Kesling and Weiss, 1953; p. 64, pl. 4, fig. 39 (Middle Devonian, Michigan); Ropolonellidae.

Ruptivelum bacculatum Kesling and Weiss, 1953; p. 47, pl. 1, figs. 22-30 (Middle Devonian, Michigan); Hollinidae.

Saccelatia alata Kummerow, 1953; p. 26, pl. 7, fig. 9a-b (Middle Devonian, Germany); Leperditellidae.

Saccelatia cingulata Kummerow, 1953; p. 26, pl. 2, fig. 14a-c (Middle Devonian, Germany); Leperditellidae.

Schmidtella? elongata Kummerow, 1953; p. 24, pl. 2, fig. 13a-c (Middle Devonian, Germany); Leperditellidae.

Schmidtella minima Kummerow, 1953; p. 24, pl. 2, fig. 12a-c (Middle Devonian, Germany); Leperditellidae.

Sigynus dictyotus Kesling, 1953*e*; p. 5, pl. 1, figs. 10-12 (Middle Devonian, Ontario, Canada); Aechminidae.

Silenites robustus Kummerow, 1953; p. 54, pl. 6, fig. 5a-b (Middle Devonian, Poland); Bairdiidae.

Silenites symmetricus Kummerow, 1953; p. 54, pl. 6, fig. 4a-b (Middle Devonian, Germany); Bairdiidae.

Stenocypris exigua Rome, 1953; p. 34, pl. 1, figs. 1-15 (Recent, Belgian Congo, Africa); Cypridae, Cyprinae.

Stibus binodosus Swain, 1953*a*; p. 274, pl. 38, fig. 7a-b (Lower Devonian, Tennessee); Thlipsuridae.

Strepulites swartzi Swain, 1953*a*; p. 272, pl. 38, fig. 5a-d; tfs. 15-16 (Lower Devonian, Tennessee); Thlipsuridae.

Subligaculum biorthogonium Kesling and Weiss, 1953; p. 46, pl. 2, figs. 18-20 (Middle Devonian, Michigan); Hollinidae.

Subligaculum calcaratum Kesling, 1953*d*; p. 209, pl. 1, figs. 14-20; pl. 4, figs. 30-31, 34-35 (Middle Devonian, Ontario, Canada); Hollinidae.

Subligaculum proclivisulcatum Kesling and Tabor, 1953; p. 95, pl. 1, figs. 3-4 (Middle Devonian, Michigan); Hollinidae.

Subligaculum trullatum Kesling and Weiss, 1953; p. 45, pl. 2, figs. 15-17 (Middle Devonian, Michigan); Hollinidae.

Tallinnella kiaeri Henningsmoen, 1953*b*; p. 40, pl. 1, fig. 4; pl. 4, figs. 1-6 (Middle Ordovician, Norway); Tetradellidae.

Tallinnella mjoesensis Henningsmoen, 1953*b*; p. 39, pl. 1, fig. 3; pl. 3, figs. 1-5 (Middle Ordovician, Norway); Tetradellidae.

Tallinnella trident Henningsmoen, 1953*b*; p. 37, pl. 1, fig. 1; pl. 2, figs. 1-2 (Middle Devonian, Norway); Tetradellidae.

Tallinnella tumida Henningsmoen, 1953*b*; p. 38, pl. 1, fig. 2; pl. 2, figs. 3-4 (Middle Ordovician, Norway); Tetradellidae.

Tetradella latecostata Kummerow, 1953; p. 38, pl. 3, figs. 16-17 (Midle Devonian, Germany); Beyrichiidae.

Tetrasacculus paeneloculatus Kesling and Weiss, 1953; p. 42, pl. 1, figs. 14-18 (Middle Devonian, Michigan); Hollinidae.

Tetrastorthynx diabolicus Kesling 1953*c*; p. 196, pl. 1, figs. 7-10 (Middle Devonian, Ontario, Canada); Drepanellidae.

Thlipsurina tenuis Kummerow, 1953 (non *Thlipsurina* Bassler, 1941); p. 50, pl. 7, fig. 10a-b (Middle Devonian, Germany); Thlipsuridae.

Tmemolophus margarotus Kesling, 1953*c*; p. 194, pl. 1, figs. 1-6 (Middle Devonian, Ontario, Canada); Drepanellidae.

Toulminia hyalokystis Munsey, 1953; p. 7, pl. 2, figs. 26-27; tf. 1 (Paleocene, Alabama); Cytheridae, Cytherinae.

Trachyleberis enborni Bowen, 1953; p. 287, tf. A (8a-b) (Eocene, British Isles); Trachyleberidae, Trachyleberinae.

Trachyleberis lytteltonensis Harding and Sylvester-Bradley, 1953; p. 4, tfs. 2-19, pl. 1, figs. 1-4, 7; pl. 2, figs. 1-4, 7-8 (Recent, New Zealand; species ranges from Upper Miocene to Recent).

Trachyleberis radiata Malkin, 1953*a;* p. 791, pl. 81, figs. 12-14 (Middle Miocene, New Jersey and Maryland).

Ullerella triplicata Henningsmoen, 1953*b;* p. 46, pl. 1, fig. 9; pl. 5, figs. 5-6 (Middle Ordovician, Norway); family uncertain.

Ullerella ventroplicata Henningsmoen, 1953*b;* p. 47, pl. 1, fig. 10; pl. 5, figs. 3-4; tf. 1 (Middle Ordovician, Norway); family uncertain.

Ulrichia alata Öpik, 1953; p. 30, tf. 11a (Lower Silurian, Australia).

Ulrichia illinearis Kesling, 1953*c;* p. 199, pl. 1, figs. 28-32 (Middle Devonian, Ontario, Canada); Drepanellidae.

Waylandella retusa Kummerow, 1953; p. 56, pl. 6, fig. 9a-b (Middle Devonian, Poland); Bairdiidae.

Winchellatia deliquiata Kesling and Tabor, 1953; p. 90, pl. 2, figs. 24-29 (Middle Devonian, Michigan); Hollinidae.

Winchellatia deminuta Kesling and Tabor, 1953; p. 91, pl. 2, figs. 20-23 (Middle Devonian, Michigan); Hollinidae.

Xystinotus wrightorum Kesling, 1953*c;* p. 198, pl. 1, figs. 17-21 (Middle Devonian, Ontario, Canada); Drepanellidae.

NEW NAMES IN 1953

Amphissites robustus flabelluli McLaughlin, 1953, p. 298, for *Amphissites robustus radiatus* McLaughlin, 1952 (non *Amphissites radiatus* (Jones and Kirkby) of Latham, 1932).

Cytherura purireticulata Edwards in Puri, 1953*a*, p. 750, for *Cytherura reticulata* Edwards, 1944 (non *Cytherura reticulata* Lienenklaus, 1894).

Healdia camdenensis Swain, 1953*a*, p. 278, for *Thlipsurina simplex* Bassler, 1941 (non *Healdia simplex* Roundy, 1926).

Healdia clavis McLaughlin, 1953, p. 298, for *Healdia unispinosa* McLaughlin, 1952 (non Hamilton, 1942).

Loxoconcha purisubrhomboidea Edwards in Puri, 1953*a*, p. 750, for *Loxoconcha subrhomboidea* Edwards, 1944 (non Brady, 1880).

Paracytheridea vandenboldi Puri, 1953*a*, for *Cytheropteron nodosum* Ulrich and Bassler, 1904 (non Brady, 1868).

Puriana Coryell and Fields in Puri, 1953*a*, p. 751, for *Favella* Coryell and Fields, 1937 (non Jörgensen, 1925).

FORMS WITH NOMENCLATURA APERTA IN 1953

Aechmina sp., Kesling, 1953*e*, p. 4, pl. 1, figs. 17-18 (Middle Devonian, Ontario, Canada); Aechminidae.

Aechmina sp. A, Kesling and Weiss, 1953, p. 49, pl. 3, figs. 12-13 (Middle Devonian, Michigan); Aechminidae.

Aechmina sp. B, Kesling and Weiss, 1953, p. 50, pl. 3, fig. 14 (Middle Devonian, Michigan); Aechminidae.

Aechminaria sp. cf. *A. hormathota* Kesling, 1953; Kesling, 1953*e*, p. 7, pl. 1, figs. 13-16, 19-20, 23 (Middle Devonian, Ontario, Canada); Aechminidae.

Aechminaria sp., Kesling, 1953*e*, p. 7, pl. 1, figs. 6-7 (Middle Devonian, Ontario, Canada); Aechminidae.

Aparchites? sp., Kummerow, 1953, p. 26, pl. 5, fig. 6a-b (Middle Devonian, Germany); Leperditellidae.

Arcyzona sp., Kesling and Weiss, 1953, p. 52, pl. 3, figs. 37-38 (Middle Devonian, Michigan); Kirkbyidae.

Bairdia sp., Munsey, 1953, p. 6, pl. 3, figs. 15-16 (Paleocene, Alabama); Bairdiidae.

Barychilina sp., Kesling and Weiss, 1953, p. 65, pl. 4, fig. 53 (Middle Devonian, Michigan); Barychilinidae.

Bythocythere? sp., Key, 1953, p. 164, pl. 2, fig. 3a-e (Recent, marine, Indonesia).

Candona sp., Lankford, 1953, p. 104, pl. 13, figs. 3-4 (Upper Cretaceous, Utah); Cypridae.

Ceratopsis? sp., Henningsmoen, 1953*b*, p. 42, pl. 1, fig. 5; pl. 2, fig. 5 (Middle Ordovician, Norway); Tetradellidae.

Cypridina sp., Iles, 1953, p. 270 (Recent, marine, southwest Africa).

Cythereis(?) sp., Gauger, 1953, p. 90, pl. 11, figs. 6-8 (Upper Cretaceous, Wyoming); Cytheridae.

Cytherella? sp., Lankford, 1953, p. 94, pl. 16, fig. 6 (Upper Cretaceous, Utah); Cytherellidae.

Cytherelloidea? sp., Key, 1953, p. 156, pl. 1, fig. 1a-b (Recent, marine, Indonesia).

Cytheropteron? sp., Lankford, 1953, p. 95, pl. 16, fig. 3 (Upper Cretaceous, Utah).

Falsipollex? sp., Kesling and Tabor, 1953, p. 93, pl. 2, figs. 18-19 (Middle Devonian, Michigan); Hollinidae.

Graphiodactylus? sp., Swain, 1953*a*, p. 271, pl. 39, fig. 1a-b (Lower Devonian, Tennessee); Quasillitidae.

Haplocytheridea? sp., Munsey, 1953, p. 14, pl. 2, fig. 25 (Paleocene, Alabama); Cytheridae, Cytherideinae.

Haploprimitia sp. e, Öpik, 1953, p. 30, pl. 11, fig. 96 (Lower Silurian, Australia).

Haploprimitia sp. f, Öpik, 1953, p. 30, pl. 11, fig. 97 (Lower Silurian, Australia).

Healdia sp., Kesling and Weiss, 1953, p. 57, pl. 5, fig. 4 (Middle Devonian, Michigan); Healdiidae.

Herpetocypris sp., Demal and Rome, 1953, p. 344, tf. 4 (no age or locality given); Cypridae.

Hollinella sp. A, Kesling and Weiss, 1953, p. 41, pl. 1, figs. 19-20 (Middle Devonian, Michigan); Hollinidae.

Hollinella sp. B, Kesling and Weiss, 1953, p. 41, pl. 1, fig. 21 (Middle Devonian, Michigan); Hollinidae.

Hollinella sp., Kummerow, 1953, p. 13, pl. 1, fig. 5a-b (Upper Carboniferous; test well no. 2, northeast of Bytom, Poland, at 0-15 and at 45-60 meters; and well no. 201 near Grodziec, Poland, at 172.00 meters); Beyrichiidae.

Krausella sp., Kummerow, 1953, p. 50, pl. 2, fig. 5 (Lower Devonian, Germany); Beecherellidae.

Metacypris? sp., Lankford, 1953, p. 105, pl. 13, fig. 5 (Upper Cretaceous, Utah); Cypridae.

Metacypris? sp., Lankford, 1953, p. 105, pl. 16, fig. 5 (Upper Cretaceous, Utah); Cypridae.

Monoceratina sp. A, Key, 1953, p. 165, pl. 2, fig. 4a-c (Recent, marine, Indonesia).

Monoceratina sp. B, Key, 1953, p. 165, pl. 2, fig. 5a-c (Recent, marine, Indonesia). (Author notes on reprint: = *Bythoceratina* cf. *B. utilazea* Hornibrook, 1952.)

Orthonotacythere sp., Peterson, 1953, p. 49, pl. 3, fig. 10a-b (Upper Cretaceous, Utah); Cytheridae.

Pachydomella? sp., Swain, 1953*a*, p. 282, pl. 39, fig. 9 (Lower Devonian, Tennessee); family uncertain.

Ponderodictya sp., Kesling and Weiss, 1953, p. 67, pl. 5, fig. 11 (Middle Devonian, Michigan); Cytherellidae.

Stenocypris sp., Triebel, 1953*b*, p. 12, pl. 2, figs. 15-16 (Oligocene, Germany).

Subligaculum? sp., Kesling, 1953*d*, p. 210, pl. 3, figs. 29-32; pl. 4, figs. 22-29, 32-33, 36-45 (Middle Devonian, Ontario, Canada); Hollinidae.

Tetradella sp. cf. *T. quadrilirata* (Hall and Whitfield); Kesling and Hussey, 1953, p. 89, pl. 2, figs. 1-24 (Upper Ordovician, Ohio); Tetradellidae.

SUPPLEMENT TO BIBLIOGRAPHY FOR 1950–1952

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1951 – *Note sur quelques ostracodes fossiles du Purbeckien de Suisse.* Archives des Sciences, vol. 4, fasc. 3, pp. 209-212.

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1950 – *Contributions to the freshwater fauna of India; Part 2.* Indian Mus., Calcutta, Rec., vol. 48, pt. 1, pp. 9-28, tfs. 1-8; Ostracoda, pp. 23-25, tf. 7.

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1952 – *A Foveaux Strait oyster bed.* New Zealand Jour. Sci. Technol., sect. B., vol. 34, no. 2, pp. 73-85; ostracodes, p. 83. (Contains a list of species identified by N. de B. Hornibrook.)

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1952 – *Paläontologische Untersuchungen zur Grenze Gotlandium/Devon im Kellerwald und bei Marburg.* Pal. Zeitschr., vol. 25, no. 3-4, pp. 160-180 (not seen).

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1952 – *Über Süsswasser-Ostracoden aus der Türkei.* Istanbul, Univ., Hydrobiol. Res. Inst., Publ., vol. 1, pp. 7-32, 27 figs.

Staub, E. W.

1950 – *Mikropaläontologische Untersuchungen im Tertiär zwischen Ehingen und Ulm a. d. Donau.* Geol. Jahrb., Hannover, vol. 66, pp. 433-523; Ostracoda, pl. a, figs. 22-35; pls. b-c; tfs. 4-24.

Usbeck, I.

1952 – *Zur Kenntnis von Mikrofauna und Stratigraphie im unteren Lias alpha Schwabens.* Neues Jahrb. Geol. Pal., Abh., vol. 95, no. 3, pp. 371-476; ostracodes, pp. 403-406, 415-467, pls. 18-19, figs. 67-68; tfs. 8-9.

SUPPLEMENT TO NEW GENERA FOR 1950–1952

Paracytheropteron Ruggieri, 1952, subgenus of *Paracytheridea; Cytheropteron calcaratum* Seguenza, 1880; p. 78, pl. 6, figs. 1-3; pl. 7, fig. 7 (Pliocene, Italy); Pliocene, marine.

Rectotrachyleberis Ruggieri, 1952, subgenus of *Trachyleberis; Cythereis hamata* Müller; p. 96 (Miocene to Recent); Miocene to Recent, marine.

Tetracytherura Ruggieri, 1952; *Cytheridea angulosa* Seguenza, 1880; p. 86, pl. 7, figs. 7-8 (Oligocene to Pliocene, Italy); Oligocene to Pliocene, marine.

The following genera, subfamilies and families proposed from 1950 to 1952 are discussed by Polenova, 1952; however, the references are as yet unknown to me.

Cavellininae Egerov, 1950, of family Kloedenellidae. (Polenova, 1952, p. 106, mentions under subfamily: *Donellina, Semilukiella, Sulcocavellina,* and *Cavellina.*)

Dizygopleurinae Egerov, 1950, of family Kloedenellidae. (Polenova, 1952, p. 104, mentions here: *Dizygopleura.*)

Donellina Egerov, 1950, Kloedenellidae, Cavellininae (Polenova, 1952, p. 106).

Evlanella Egerov, 1950, Kloedenellidae, Lichwiniinae (Polenova, 1952, p. 89).

Healdianella Posner, 1951, Healdiidae (Polenova, 1952, p. 121).

Kalugia Egerov, 1950 (compared with *Evlanella* by Polenova, 1952, p. 90).

Knoxiella Egerov, 1950, Kloedenellidae, Knoxinae (Polenova, 1952, p. 94).

Knoxinae Egerov, 1950. (Polenova, 1952, p. 94, places here *Knoxiella* and *Knoxites.*)

Knoxites Egerov, 1950 (Polenova, 1952, p. 94).

Lichwinia Posner, 1951(?) (compared with *Evlanella* by Polenova, 1952, p. 90).

Lichwiniinae Posner, 1951(?), of family Kloedenellidae. (Polenova, 1952, p. 89, places here *Evlanella* Egerov, 1950.)

Lunularia (discussed under Acronotellidae, Graviinae, by Polenova, 1952, p. 82).

Scrobicula Posner, 1951; genotype *Cytherella scrobiculata* Jones, Kirkby and Brady, 1884, p. 76, pl. 6, fig. 10 (assigned to family Scrobiculidae Posner, 1951, in Polenova, 1952, p. 119).

Scrobiculidae Posner, 1951 (apparently for genus *Scrobicula* Posner, 1951; Polenova, 1952, p. 120).

Selebratina (discussed under Acronotellidae, Graviinae, by Polenova, 1952, p. 82).

Semilukiella (discussed by Polenova, 1952, p. 107, under Kloedenellidae, Cavellininae).

Sulcatia (discussed by Polenova, 1952, p. 82, under Acronotellidae, Graviinae).

Sulcocavellina (discussed by Polenova, 1952, p. 107, under Kloedenellidae, Cavellininae).

notes and comment

Reprint of Sherborn's "An index to the genera and species of the foraminifera"

ALFRED R. LOEBLICH, JR.

U. S. National Museum
Washington, D. C.

The comprehensive "An index to the genera and species of the foraminifera," by Charles Davies Sherborn, originally published by the Smithsonian Institution in two parts in 1893 and 1896, is being reprinted. It will be bound in cloth in one volume, and will be 485 pages in length. Copies may be obtained from the Editorial and Publications Division, Smithsonian Institution, Washington 25, D. C., price $3.50.

Sherborn's index includes all species described up to and including 1889. This important reference to the genera and species of the foraminifera has long been out of print and unavailable to many students of the foraminifera. Hans Thalmann has recently completed for publication an index continuing the work of Sherborn from 1890 to 1950. Upon publication of Thalmann's work, which does not deal with species prior to 1890, students will have available, in these two publications, an index complete to 1950.

A training and research center

BROOKS F. ELLIS

American Museum of Natural History
New York

Arrangements have just been completed to establish a spore and pollen training and research center as part of the graduate program of the Department of Geology at New York University. The center will be located in the American Museum of Natural History, and will operate as part of the Department of Micropaleontology there. Professor L. R. Wilson of the University of Massachusetts will have charge of this activity as a visiting professor to New York University.

The first course in spore and pollen analysis will be offered during the coming academic year. A class of ten students has already been enrolled, and registration has been closed. A comprehensive research program will be inaugurated shortly after the first of the coming calendar year.

This training center has been made possible through the generosity of the Socony-Mobil Oil Company and The Texas Company. Professor Wilson, Dr. Eugene Jablonski, Walter Olson, Dr. Verner Jones and Dr. William S. Hoffmeister have all given generously of their time and efforts to make this spore and pollen training center a reality.

memorial

D. Dale Condit (1886-1955)

D. DALE CONDIT

With the death of D. Dale Condit on May 6, 1955, the Department of Micropaleontology of the American Museum of Natural History lost one of its most steadfast supporters. Although not a micropaleontologist himself, Dale was well aware of the role of microfossils in oil finding, and never missed an opportunity to further their study. This deep-rooted interest in micropaleontology brought Dale into contact with the Department of Micropaleontology in the early 1940's. Soon thereafter he became a member of the Board of Advisers on Micropaleontology, on which he served as the official representative of the Standard Vacuum Oil Company until his death. He was also one of the most active members of the Executive Committee of that Board, and in this capacity helped to develop and promote many of the projects undertaken by the Department of Micropaleontology. This quarterly was one of the very last of such undertakings which his efforts helped to initiate. He saw the need for a publication devoted to microfossils and the possibilities for service to science, and devoted himself tirelessly to its furtherance.

Dale Condit was one of the most widely traveled petroleum geologists in the profession. His travels gave him an opportunity to collect, and he seldom returned to New York without important new material for the departmental collection of types and faunas. Many gifts of fossil material from others have arrived with the notation that they were being sent at the suggestion of D. Dale Condit.

Although Dale made many material contributions to the Department, perhaps his greatest service grew out of his steadfast faith in the destiny of micropaleontology at the American Museum. In times of stress, his gentle humor and wise counsel did much to reduce tension and restore a normal outlook. The members of the Board of Advisers and the Editors of Micropaleontology join in expressing their deep sorrow and great sense of personal loss in the passing of a valued colleague and friend.

BROOKS F. ELLIS
Department of Micropaleontology
American Museum of Natural History
New York

news reports

BRAZIL

FREDERICO W. LANGE

Divisão de Geologia e Mineralogia

Several members of this federal institution have been working on systematic micropaleontology. Wilhelm Kegel has published a short paper on microfossils from the Upper Cretaceous (Maestrichtian) phosphatic deposits of Olinda, Pernambuco. Professor Kegel found that in certain places these deposits consist of up to nearly 50% of small cylindrical nodules which were identified as probable worm or gastropod coprolites, similar to the forms described as *Coprulus*. In addition, the phosphate contains the following foraminifera: *Siphogenerinoides* sp., *Quinqueloculina* sp., *Q. antiqua angusta*, and *Saracenaria* cf. *saratogana*.

Friedrich Wilhelm Sommer has three papers ready for publication. The first of these, in which he describes the Paleocene seed *Celtis santosi*, relates to fossil plant remains from the Itaboraí basin. The second deals with the Devonian microflora of eastern Bolivia. This paper will be part of a more extensive work on South American Paleozoic sporomorphae without haptotypic structures. In his last paper, entitled "Palynology as an aid in coal petrography," he summarizes palynologic research relating to the Gondwana coals.

Ivan de Medeiros Tinoco has started work on Cretaceous and Tertiary foraminifera recovered from cores of the Itamaracá well, Pernambuco.

Conselho Nacional do Petróleo

Setembrino Petri has left the foraminiferal research laboratory of this institution in Belém, Pará, which at present has no paleontologist in charge of the work. During his service in this laboratory he studied a great many Miocene, as well as some reworked Eocene and Cretaceous foraminifera from the Cururú well on Marajó Island. These were described recently in an extensive paper (see list of publications). Last year Dr. Petri accepted a teaching assignment at the Faculdade de Filosofia, Ciências e Letras, Universidade de São Paulo, where he is now engaged in the study of Miocene foraminifera from the Pirabas formation of Pará.

Universidade do Rio Grande do Sul

Irajá Damiani Pinto, Director of the Instituto de Ciências Naturais of this university, is engaged in the study of Paleozoic ostracodes, part of which were collected in Paraná during a field trip with your correspondent.

Museu Paranaense

Your correspondent was elected Director of this institution at the beginning of 1954, and since then administrative work has taken up nearly all of his time, so that his research on Silurian microfossils from the Amazon basin has progressed very slowly. The vertical distribution of Jurassic ostracodes in cores from the Bahia region has been studied.

Petróleo Brasileiro S. A. (PETROBRÁS)

This company, which incorporates both federal government and private interests, is in charge of oil prospecting work and related research for the whole of Brazil. At the beginning of 1955, your correspondent took a temporary leave from his teaching position at the Faculdade de Filosofia de Curitiba, to establish a laboratory of paleontology and subsurface geology for PETROBRÁS in Ponta Grossa, Paraná. Though primarily designed for both micro- and macro-paleontological research relating to the Paraná oil basin, the laboratory has also been engaged in the study of microfossils from cores of wells in the Amazon basin. The new laboratory is being equipped to handle all regular investigations connected with subsurface geology, and several assistants are being trained to complete the technical staff.

Recent publications

KEGEL, W.
1954 – *Nota sôbre os microfósseis do fosfato Cretáceo de Pernambuco.* Soc. Brasileira Geol., Bol., vol. 3, no. 1, pp. 73-76, figs. 1-2.

PETRI, S.
1954 – *Foraminíferos fósseis de Bacia do Marajó.* São Paulo, Univ., Fac. Filos. Ci. Letras, Bol., no. 176 (Geol., no. 11), pp. 1-178, pls. 1-14, 6 tfs., 3 sections, 1 map.

F. W. LANGE
Ponta Grossa, Paraná
Brazil

FRANCE

JEAN CUVILLIER

Institut Français du Pétrole

During 1954, the three sections of the Laboratory of Micropaleontology (foraminifera, ostracodes, and pollen), under the direction of M. Lys, carried on a large number of operations of an industrial nature, which were principally concerned with West Africa, North Africa, the Sahara, and, in France, the Aquitaine Basin and the Rhone Corridor. In addition, the ostracode section, under the direction of M. Grékoff assisted by M. Deroo, continued its work of assembling basic data, and compiled a file of genera and species which now contains more than 2500 index cards. Special studies are now in progress on the ostracode faunas of the Jurassic and Tertiary. The pollen section, under the direction of M. Sittler, is in full swing. Specifically, this section is compiling basic data in the form of collections and index cards on the Mesozoic assemblages that are as yet insufficiently known.

The Institut Français du Pétrole organized a conference of the micropaleontologists of western Europe, which took place September 18th to 25th, 1954, in order to promote contacts between micropaleontologists of different countries. A series of field trips were conducted to type localities in the Paris Basin, in order to collect specimens from the Tertiary, Cretaceous and Jurassic sequences exposed there, leading to the exchange of material and to scientific discussions. The conference brought together about forty micropaleontologists, both industrial and academic. Among them were ten micropaleontologists from Germany, three from England, one from Austria, three from Belgium, one from Holland, and one from Switzerland. The type localities visited were those described in the works of Abrard, Cornuel, Cushman, Lienenklaus, P. Marie, d'Orbigny and Terquem.

On September 20th, under the direction of MM. Lys, N. Grékoff, and Professor R. Abrard of the Muséum d'Histoire Naturalle de Paris, the type localities of the Auversian (Pontoise, Auvers, Marines, Liancourt St. Pierre, Beauvais, Bracheux, and Méru), northwest of Paris, were visited. On September 21st, the field trip covered the type localities of the Upper Cretaceous and the Stampian (Meudon, Mantes, Villiers St. Fréderic, Montfort, Rambouillet, Étampes, Ormoy-Vauvert, Jeurres, and Auvers St. Georges), southwest of Paris.

The field trip of September 22nd demonstrated the Lower and Upper Cretaceous of the environs of Paris, and especially the type localities of the Senonian (Montereau, Sens, Troyes, Brienne, and St. Dizier). On September 23rd, under the leadership of M. V. Stchepinsky, the type collections of Cornuel at the Museum of St. Dizier, and the corresponding Lower Cretaceous localities of St. Dizier, Wassy, and Bar-le-Duc, were visited. September 24th and 25th, under the direction of P. L. Maubeuge, were devoted to the study of the Jurassic of the vicinity of Nancy, particularly the type localities of the Lias studied by Terquem.

We are pleased to report that M. Sigal has completely recovered from his recent illness and has resumed his work on the Cretaceous.

University of Paris

The activities of the Centre d'Études de Micropaléontologie again expanded notably during the past year, as a result of the acquisition of new material and of the work of a steadily increasing number of research workers. Mlle. G. Aurouze has been making a detailed study of the Jurassic of Lorraine and the region around Paris, in cooperation with the Société Nationale des Pétroles du Languedoc et Méditerranée. Part of her time was also spent identifying Eocene microfaunas from Senegal. Mlle. L. Biot, having completed a study of Miocene foraminifera from Morocco, has resumed her work on the Upper Cretaceous microfaunas of Aquitaine in the collections of the Centre de Micropaléontologie. At present she is making a thorough study of the phosphatic chalks of northern France. Mme. M. Neumann is continuing to work intensively on her revision of the Orbitoididae of Aquitaine. She has concentrated primarily on the stellate orthophragmines, thus complementing her previous research on the discocyclines and their accompanying microfaunas. D. Boulanger, who has begun a revision of the Nummulitic of Landes, has already reported some interesting findings, stratigraphic as well as micropaleontologic, especially concerning the Lower Eocene. M. Sarkar has submitted, as a second thesis for the Doctorate in Science, a study of some operculines from Aquitaine which were placed at his disposal by M. Cuvillier. Three diplomas in Graduate Studies, based on systematic studies of microfacies and microfaunas from Aquitaine, were earned during the past year, by Mlle. J. Mineur, who worked on the region of Salies-de-Béarn; by Mlle. A. Moreau, who wrote on the Louer-Montfort anticline; and by M. A. Poignant, whose topic was the region between Dax and Peyrehorade.

Mlle. Chenouard, whose laboratory work was concerned with the micropaleontology of Aquitaine, was hired at the end of last year by the Geological Service of the S. P. A. E. F., at Port-Gentil, Gabon.

J. Cuvillier, who coordinates the activities of the Centre de Micropaléontologie, has prepared the second edition of his "Corrélations par microfaciès en Aquitaine occidentale." It will include the uppermost Jurassic and the Neocomian, which were recently discovered for the first time in southwestern France.

University of Dijon

During 1954, the operations of the Laboratoire de Géologie et de Micro-

paléontologie, which is directed by Professor Ciry, were concerned with the following general subjects, which were studied from a systematic or an ecological point of view, or for the purpose of stratigraphic application:

Paleozoic: R. Ciry is working on the fusulinids of Tunisia.

Jurassic: The smaller foraminifera of the Upper Jurassic of Bourgogne were studied by H. Tintant.

Cretaceous: The microfaunas of the basal Wealdian and of the Upper Cretaceous marls of northern Spain are the subject of studies by P. Rat.

Nummulitic: J.-Ph. Magin is working on larger foraminifera from the Eocene and Oligocene, and on smaller foraminifera from the upper Oligocene of the southern Pyrenees. His wife is making a systematic and ecological study of assemblages of smaller foraminifera from the marls of Biarritz.

Neogene: Smaller foraminifera from the Neogene of Turkey are being studied by H. Tintant. In addition, beginning this year, P. Rat has directed the publication of the Bulletin Scientifique de Bourgogne, which carries some of the papers on natural history by members of the Faculty of Sciences of Dijon University.

Société Nationale des Pétroles d'Aquitaine

A. Debourle, who is in charge of the laboratory at Pau, is working with M. Delmas on the determination of the stratigraphy of the beds penetrated as drilling progresses. In the northern part of the S. N. P. A. area, they have recently found Miocene and Oligocene microfaunas, which have been subjected to a careful study. The abundance of microfacies constantly poses new problems, but because the assemblages are very diagnostic, it has been possible to identify the uppermost Jurassic and the Neocomian for the first time in wells at Sainte-Suzanne and Lacq.

M. Debourle is also continuing the systematic revision of the Paleocene and Lower Eocene of the Basses-Pyrénées. M. Delmas has completed the work for his diploma in Graduate Studies. He worked on the Flysch of the region of Saint-Jean-de-Luz.

Following the discovery, together with A. Debourle, of the uppermost Jurassic and lowermost Cretaceous, J. Cuvillier has begun a restudy of numerous old wells, in which these rocks, which are the principal oil reservoirs, were not dated satisfactorily.

M. Gotszorg has replaced M. Dufaure in the laboratory at Nancy, where the work of establishing micropaleontological standard sections for the area has been continuing.

Régie Autonome des Pétroles, Saint-Gaudens

The Laboratoire Central of the R. A. P. at Saint-Gaudens, under the direction of M. Pérébaskine, has continued the study of well and surface samples from various fields in France and in the Sahara (C. R. E. P. S.), extending from the Paleozoic to the Tertiary.

Société Nationale des Pétroles Languedoc-Méditerranée

The laboratory has worked principally on material from wells in the Paris area (Cretaceous). It has also carried on a study of Pliocene material from southeastern France. A study of field samples from the Paris Basin, both thin sections and washed samples, has been started, for the purpose of establishing a Jurassic and Cretaceous stratigraphic scale based on foraminifera and ostracodes.

Bureau de Recherches Géologiques, Géophysiques et Minières

P. Marie, Chief of the Laboratoire de Micropaléontologie, announced that Mme. Y. Le Calvez, the widow of our esteemed late colleague J. Le Calvez, former Professor of Zoology at the Faculté des Science, has returned to the laboratory, where she has resumed her studies of the Tertiary.

In addition to his numerous current research activities concerned with French material, P. Marie has discovered a new species of *Austrotrillina* in an Aquitanian reef limestone from Greece, a description of which will appear in an early issue of the Bulletin of the Société Géologique de France.

Among several new genera discovered in the French Upper Cretaceous of reef facies, M. Marie named one new genus *Reichelina*. However, since the Congress at Algiers, it has been learned that this generic was previously proposed by Erk in 1941 for a form of the family Fusulinidae. Marie's form will therefore have to be renamed, and he proposes to do so in the near future.

Recent publications

ABRARD, R.
1954 – *Les formes de passage dans le rameau phylétique Nummulites atacicus Leymerie – Nummulites aturicus Joly et Leymerie.* Soc. Géol. France, C. R. Somm., no. 7, pp. 145-147.

APOSTOLESCU, V.
1954 – *Répartition de quelques ostracodes du Lutétien du Bassin de Paris.* Inst. Franç. Pétrole, Rev., vol. 9, no. 12, pp. 703-706.
[MS.] *Description de quelques ostracodes du Lutétien du Bassin de Paris.* Cahier Géologique de Thoiry (in press).

AUROUZE, G., AND BOULANGER, D.
1954 – *Ganella, n. gen., nouveau genre de foraminifère de l'Yprésien de Gan (Basses-Pyrénées).* Soc. Géol. France, C. R. Somm., no. 10, pp. 186-188.

AUROUZE, G., AND KLASZ, I. DE
1954 – *Sur la présence de schackoines dans le Crétacé supérieur de France, de Bavière et de Tunisie.* Soc. Géol. France, Bull., ser. 6, vol. 4, fasc. 1-3, pp. 97-104, pl. 6a.

BOURDON, M., AND LYS, M.
1954 – *Microfaune des marnes à Ostrea longirostris Lmk. (Stampien) de la carrière de la Souys-Floirac (Gironde).* Soc. Géol. France, C. R. Somm., no. 13, pp. 336-338.

BUTTERLIN, J.
1954 – *La géologie de la République d'Haïti et ses rapports avec celle des régions voisines.* Inst. Franç. Haïti, Mém., no. 1, 446 pp., 20 figs., 26 pls.

CIRY, R.
1954 – *A propos de Neoschwagerina syrtalis Douvillé.* Soc. Sci. Nat. Tunisie, Bull., vol. 7 (1953-1954), pp. 111-122, pl. 20.

CIZANCOURT, M. DE
1954 – *Quelques commentaires sur Miscellanea antillea (Hanzawa) M. de Cizancourt et Operculinoides georgianus Cole et Herrick.* Soc. Géol. France, C. R. Somm., no. 9, pp. 178-179.

CIZANCOURT, M. DE, AND CUVILLIER, J.
1954 – *Les Nummulites cordelées du Sénégal occidental.* Soc. Géol. France, C. R. Somm., no. 7, pp. 130-133.

CUVILLIER, J.
1954 – *Niveaux à coprolithes de crustacés.* Soc. Géol. France, Bull., ser. 6, vol. 4, fasc. 1-3, pp. 51-53, pl. 3.

1955 – *À propos des "Corrélations stratigraphiques par microfaciès en Aquitaine occidentale."* Soc. Géol. France, Bull., ser. 6, vol. 4, fasc. 4-6, pp. 233-236.

CUVILLIER, J., AND DEBOURLE, A.
1954 – *Découverte du Jurassique terminal et du Néocomien en Aquitaine occidentale et méridionale.* Soc. Géol, France, C. R. Somm., no. 4, pp. 75-76.

1954 – *Dispersion du Jurassique terminal et du Néocomien en Aquitaine occidentale.* Soc. Géol. France, C. R. Somm., no. 16, pp. 408-410.

DAVID, L., AND FLANDRIN, J.
1955 – *Sur la présence du Miocène à miogypsines dans les monts de la Haute Medjerda.* Soc. Géol. France, Bull., ser. 6, vol. 4, fasc. 4-6, pp. 415-419, pl. 15.

DEBYSER, J., AND CALLAME, B.
1954 - *Observations sur les mouvements des diatomées à la surface des sédiments marins de la zone intercotidale.* Vie et Milieu (Bull. Lab. Arago), vol. 5, fasc. 2, pp. 243-250.

DELMAS, M., AND DIENESCH, J.
1954 – *Présence du Néocomien sur le flanc nord du Pic de Rébénacq (Basses-Pyrénées).* Soc. Géol. France, C. R. Somm., no. 14, pp. 357-358.

DEFLANDRE, G., AND COOKSON, I. C.
1954 – *Sur le microplancton fossile conservé dans diverses roches sédimentaires australiennes s'étageant du Crétacé inférieur au Miocène supérieur.* Acad. Sci., C. R., vol. 239, no. 19, pp. 1235-1238.

DEFLANDRE-RIGAUD, M.
1954 – *Microfossiles des silex sénoniens du Bassin de Paris.* Soc. Géol. France, C. R. Somm., no. 3, pp. 58-59.

DELEAU, P., AND MARIE, P.
1954 – *Les calcaires oolithiques du Namurien du Sud Oranais et leur faune de foraminifères.* Soc. Géol. France, C. R. Somm., no. 11, pp. 225-226.

DEUNFF, J.
1954 – *Sur un microplancton du Dévonien du Canada, recélant des types nouveaux d'Hystrichosphaeridés.* Acad. Sci., C. R. vol. 239, no. 17, pp. 1064-1066.

1954 – *Sur le microplankton du Gothlandien armoricain.* Soc. Géol. France, C. R. Somm., no. 3, pp. 54-55.

1954 – *Microorganismes planctoniques (hystrichosphères) dans le Dévonien du massif armoricain.* Soc. Géol. France, C. R. Somm., no. 11, pp. 239-242.

1954 – *Veryhachium, genre nouveau d'hystrichosphère du Primaire.* Soc. Géol. France, C. R. Somm., no. 13, pp. 305-307.

FAURE-MURET, A., AND FALLOT, P.
1954 – *La formation à Microcodium au pourtour de l'Argentera-Mercantour.* Soc. Géol. France, Bull., ser. 6, vol. 4, fasc. 1-3, pp. 111-139.

FAURE-MURET, A., ABRARD, R., AND FALLOT, P.
1954 – *Observations nouvelles sur le Nummulitique des abords du massif de l'Argentera-Mercantour.* Acad. Sci., C. R., vol. 238, no. 4, pp. 421-423.

GRÉKOFF, N.
1954 – *Sur l'évolution et la répartition de quelques genres d'ostracodes dans la série géologique postpaléozoïque.* Soc. Géol. France, C. R. Somm., no. 13, pp. 333-336.

LE CALVEZ, Y., AND LEFAVRAIS, A.
1954 – *Extension de la mer miocène en Bresse.* Soc. Géol. France, C. R. Somm., no. 7, pp. 137-138.

MANGIN, J.-PH.
1954 – *Description d'un nouveau genre de foraminifère: Fallotella alavensis.* Bull. Sci. Bourgogne, vol. 14, pp. 209-220, 3 tfs., pl. 3.

MARIE, P.
1954 – *Quelques genres nouveaux de foraminifères du Crétacé à faciès récifal.* Congr. Géol. Internat., 19th (Algiers, 1952), C. R., fasc. 15 (sec. 13, pt. 3), pp. 117-125, tfs. 1-5.

NEUMANN, M.
1954 – *Sur un Cibicides nouveau du Lutétien supérieur d'Aquitaine, Cibicides daguerri, n. sp.* Soc. Géol. France, C. R. Somm., no. 5, pp. 113-115.

1954 – *Le genre Linderina et quelques autres foraminifères l'accompagnant dans le Nummulitique d'Aquitaine.* Soc. Géol. France. Bull., ser. 6, vol. 4, fasc. 1-3, pp. 55-59, pls. 4-5.

NEUMANN, M., AND BOULANGER, D.
1954 – *Discorbis (Lamellodiscorbis) magna Vialli, var. aquitanica, nov. var., foraminifère caractéristique des marnes à Xanthopsis dufouri de la Chalosse (Landes).* Soc. Géol. France, C. R. Somm., no. 5, pp. 114-116.

RAT, P.
1954 – *Observations sur les faciès marins et saumâtres de la base du Wealdien dans l'Est de la province de Santander (Espagne)* Acad. Sci., C. R., vol. 239, pp. 1820-1821.

SITTLER, C.
1954 – *Présence de formes polliniques dans quelques sédiments du Kimméridgien en France.* Soc. Géol. France, C. R. Somm., no. 13, pp. 338-342.

1954 – *Palynologie et stratigraphie – Principe et application de l'analyse des pollens aux études de recherche de pétrole.* Inst. Franç. Pétrole, Rev., vol. 9, no. 7, pp. 367-375.

TINTANT, H.
1954 – *Études sur la microfaune du Néogène de Turquie; 1 – La microfaune du Pliocène de Datça.* Bull. Sci. Bourgogne, vol. 14, pp. 185-208, pl. 2, 6 tfs.

JEAN CUVILLIER
University of Paris
France

GREAT BRITAIN

During the past few years, micropalaeontology has received a great impetus in Britain, for not only are there micropalaeontologists engaged in research for the major oil companies, but a large number of university geology departments now have one or more workers actively engaged in research in pure science. In view of the amount of work going on, your correspondent may have overlooked some activity; if this is the case, an account of this research can be included in a future letter.

University of St. Andrews, Scotland

J. F. Scott is studying the microfossils from the Mesozoic rocks of the west coast of Scotland, especially from Morven and Eigg. This area is one of great importance in our study of the Jurassic stratigraphy of Britain, and we await with interest the results of this work.

University of Glasgow

R. M. Cummings has informed me that his monograph on Lower Carboniferous foraminifera is in press. Meanwhile he continues with the thankless, but nevertheless extremely important, task of preparing part of the section on Protozoa for the Zoological Record.

University of Wales, Aberystwyth

Professor Alan Wood has just returned from Australia, where he has been continuing his research on the classification and wall structures of foraminifera. We are all eagerly awaiting the results of his studies.

King's College, University of Durham

J. E. Robinson has almost completed his research on the microfauna of the Lower Carboniferous, a work which lays special emphasis on the Ostracoda.

University of Hull

J. W. Neale has recently started a study of the ostracods from the Lower Cretaceous Speeton clay.

University College of North Staffordshire

T. R. Burnaby continues his work on the palaeoecology of the foraminifera from the Chalk Marl (Cenomanian). P. H. Shelford is doing research on the Gault and Upper Greensand (Albian) facies in the Isle of Wight, Dorset and Devon. Miss A. Naylor is studying the microflora of the Colonial Developments Coalfields in the Ruhuhu Valley of Tanganyika.

University College, Exeter

R. N. C. Bowen is at present investigating a foraminiferal fauna from the Lutetian of British Somaliland.

University of London

At Imperial College, D. J. Carter and Nyi Nyi have almost completed their theses, which are, respectively, on the foraminifera of the Coralline Crag, and on the foraminifera of the Holocene clays of Lancashire and Cheshire.

All workers at University College are at present concentrating their attention on various aspects of Mesozoic micropalaeontology. W. A. Gordon is studying the stratigraphic and ecological significance of microfaunas from the Corallian. S. J. McNicol is dealing with similar aspects of the Bathonian. A. J. Lloyd has almost completed a study of the foraminifera from the type Kimmeridgian (Dorset); parts of this work are nearly ready for the press. Mr. Lloyd has also started a study of the foraminifera of the Lower Cretaceous Speeton clay of Yorkshire. Both undertakings should prove to be of great interest in correlating these successions with those of the mainland of the continent. M. W. Hughes Clarke has opened up a new field of research at University College with his study of Albian and Cenomanian ostracods. Already considerable information has been obtained on such points as taxonomy, classification, morphology and ecdysis. S. M. Omara recently returned to Egypt after a stay of several months in Britain, during which time he described some new genera of foraminifera from the Cenomanian of Egypt. Your correspondent is engaged in two main projects; first, a completion of his research on the evolution and stratigraphic significance of foraminifera from the Lias; and second, a study of Upper Cretaceous (Cenomanian to Senonian) microfaunas.

F. E. Eames (British Petroleum Company) and A. H. Smout (Iraq Petroleum Company) are studying an Upper Cretaceous fauna from Kuwait. Dr. Smout is also continuing his important investigations on the reclassification of the superfamily Rotalidea.

TOM BARNARD
*University College
London, England*

JAPAN

K. ASANO

Dr. Tsuneteru Oinomikado, who has been your correspondent for Japan, is now in Taiwan (Formosa) for the purpose of making a geological survey of the oil fields there. During his absence, Dr. Kiyoshi Asano of Tohoku University will act as correspondent.

Micropaleontology in Japan has recently been associated more closely with stratigraphy than has been the case in the past. As a result, progress, especially in the study of foraminifera and pollen, has been very rapid. Many workers are now concentrating their efforts on the study of problems relating to oil fields and the coal industry.

The recently published journal Yukochu (Foraminifera), which is issued three times per year, serves to bring micropaleontologists into closer contact with each other. Articles such as those dealing with preliminary reports, lectures, notes on laboratory techniques, and short papers are published in this journal. The newly established journal Coal Microscopy serves the same purpose for those interested in pollen.

On the occasion of the December meeting of the Paleontological Society of Japan, held in Tokyo in 1954, a special symposium was conducted under the title of "Japanese Tertiary micro-biostratigraphy." At this meeting, T. Matsunaga of the Teikoku Oil Company presented an outline of the biostratigraphy of the oil-bearing Tertiary of Japan. S. Ishiwada of the Geological Survey of Japan spoke on the Tertiary biostratigraphy of the Boso Peninsula in Chiba Prefecture. S. Iwasa of Tohoku University subdivided the Tertiary rocks of the Oga Peninsula, Akita Prefecture, into zonules by means of the Globigerinidae. From the discussion following the lectures, it became quite evident that a more precise correlation of the Tertiary deposits is possible. Problems concerning foraminifera and correlation of the Paleogene deposits were discussed by Drs. H. Yabe, K. Asano, S. Murata, and R. Saito.

A special meeting on the significance of fossil pollen from the coal fields of Japan was held under the auspices of the Geological Society of Japan in Tokyo during April, 1955. Interesting papers were presented by M. Shima-

kura, S. Tokunaga, Y. Ozaki, K. Suzuki, U. Kitazaki, M. Toyama, and S. Mabuchi.

Professor R. Toriyama of Kyushu University has restudied the Fusulinidae from the Paleozoic of the Akiyoshi Plateau and has published an outstanding paper dealing with this group. S. Hanzawa, R. Morikawa, H. Fujimoto, and K. Kanmera have reported on Fusulinidae from the Kitakami and Abukuma massifs, as well as from Kyushu.

Cenozoic foraminifera have been reported on by K. Asano, Y. Takayanagi, S. Iwasa, and Y. Higuchi of Tohoku University, by S. Kuwano of the Underground Resources Institute, by K. Nakaseko of Osaka University, and by Y. Tai of Hiroshima University. Their work on this group is being continued.

J. Iwai of Tohoku University has been engaged in a study of the Silicoflagellata, and the results of his study are to be published in the near future. K. Hatai, also of Tohoku University, is now studying Recent otoliths, with the purpose of making a comparative study with fossil ones.

KIYOSHI ASANO
Tohoku University
Sendai, Japan

MEXICO

CLEMENCIA TÉLLEZ-GIRÓN

Micropaleontological activity at Petróleos Mexicanos continues with ever-increasing intensity. As a result of field work by geologists of this organization, many samples have been collected in Baja California, the State of Tabasco, and the Angostura area in the State of Veracruz.

Paleontologists specializing in the southern zone of Mexico at the Laboratorio de Paleontología in Mexico City are investigating the significance of foraminifera in the stratigraphy of the Angostura area in Veracruz, and of the State of Tabasco. They hope to establish, in due course, a basis for subsurface correlation. Very little is known of this aspect of the geology of southern Mexico. Paleontological studies of the Macuspana region are in the capable hands of Mrs. Maria Luisa Robles.

Agustin Ayala has completed his investigation of the importance of the genus *Globotruncana* Cushman. This paper has already been published. Mr. Ayala is now studying exploration wells and subsurface samples from Baja California, with the help of a group of specialists in the Laboratory. The macrofossils of this region are being studied by Mrs. G. A. de Cserna. Miss M. E. Caso and Mrs. N. Adis are continuing their research on the mollusks. Exploration wells and subsurface samples from the Linares region are being studied by J. Alvarez, assisted by Miss G. Moreno and S. Abraham.

Dr. Bonet of the Gerencia de Exploración is still working on the Calpionellidae and Hystrichosphaeridae. Their enormous abundance in limestone sequences that are often very uniform lithologically and almost always devoid of macrofossils makes them very useful for surface stratigraphy as well as for analyses of core samples.

Recent publications

AYALA, A.
1954 – *El género Globotruncana Cushman, 1927 y su importancia en estratigrafía.* Asoc. Mex. Géol. Petr., Bol., vol. 6, nos. 11-12, pp. 352-474, pls. 1-16.

CLEMENCIA TÉLLEZ-GIRÓN
Petróleos Mexicanos
Mexico, D. F., Mexico

NORTH AFRICA

MARCEL REY

Algeria

During the past year, the main laboratory of geology of the S. N. REPAL, under the direction of J. Magné, occupied the new building erected the previous year in Oued-Samar, near Maison carrée, in the suburbs of Algiers. The staff increased with the addition of a new assistant and a new laboratory helper for picking and counting microorganisms. The staff studied 4215 residues from washing and 4613 thin sections, and carried out 400 heavy-mineral separations. The laboratory of microphotography also made a large number of thin-section photographs, which made it possible to compile sets of microfacies arranged by geologic formations and by broad geographic areas. Good correlations have been obtained in this manner.

A large part of 1954 was spent in routine work on field and well samples, but Mr. Magné, carried on his work on the microfaunas and microstratigraphy of the Algerian Jurassic, Nummulitic, and Neogene. In collaboration with J. Sigal, he has prepared a paper entitled "La micropaléontologie des niveaux de passage Crétacé-Éocène," to be presented at the Fourth World Petroleum Congress, which will be held at Rome in June, 1955. C. Tempère has made a detailed study of the microfaunas and microfacies of the Paleozoic of the western Sahara (Tafilalet and Tindouf areas) and of the Upper Cretaceous of the central Sahara. He has also begun a study of the heavy minerals of the Saharan Paleozoic, of

the Lower Cretaceous of the Saharan Atlas, and of the Oligocene of the Constantine and Algiers regions. In this manner, Mr. Tempère has distinguished characteristic assemblages of heavy minerals, and is bringing together important information on the sedimentation of sequences without micro-organisms. R. Lacassagne has begun an inventory of the Cretaceous microfacies of the Constantine region, the Hauts Plateaux and the Saharan Atlas.

At the S. N. REPAL field laboratory in Oued Guétérini (or Oued Djenan) near Sidi-Aïssa, routine work has continued under the direction of Mr. Grégoire, who has replaced J. Demians d'Archimbaud.

In the laboratory of general geology of the University of Algiers, Mme. G. Glaçon has begun a study of the Recent foraminifera of the Gulf of Gabès (Tunisia). In addition, she has continued, in collaboration with J. Glaçon, her work on the Eocene foraminifera of the Guergour area, northwest of Sétif. In the laboratory of applied geology at the University, Mlle. D. Noël, under the direction of Professor Lucas, has begun a study of the coccolithophorids of the Algerian Jurassic.

The C. P. A. (Compagnies des Pétroles d'Algérie, Shell) has equipped a geologic laboratory in Algiers for studying field and well samples from the Sahara. The personnel of the laboratory consists of two geologists, MM. Boemer and Milloud, assisted by laboratory helpers.

During the past year, MM. Sacal and Nouet of the C. F. P. A. (Compagnie Française des Pétroles d'Algérie) carried on micropaleontological and stratigraphic work in the Paleozoic and Mesozoic of the Sahara, in consultation with Mr. Cuvillier. The C. F. P. A. laboratory studied numerous field sections, and developed, with the use of thin sections, a stratigraphic scale for the Silurian and Devonian. With its several cycles, the Saharan Carboniferous is very complex. It will be the subject of a detailed study during 1955.

The C. F. P. A. laboratory also studied the Jurassic and Cretaceous facies of the Saharan Atlas and the Mesozoic sequences encountered in drilling. In spite of the scarcity of organogenic horizons, it is possible to establish good correlations. The paleogeography, based on these observations, will probably be worked out during 1955.

Mr. Nouet plans to go to Paris during the summer in order to equip a laboratory for the C. F. P. group. He will supervise the first stratigraphic work in the lower Seine area. Mr. Fediaevsky will assist Mr. Sacal in Algiers.

Recent publications

AYMÉ, A., AYMÉ, J. M., AND MAGNÉ, J.
1954 – *Étude des terrains néogènes de la cluse du Mazafran (Sahel d'Alger).* Algeria, Service Carte Géol., Bull., no. 1 (Travaux des Collaborateurs 1953), fasc. 2, pp. 129-150.

AYMÉ, A., GLANGEAUD, L., AND MAGNÉ, J.
1954 – *Sur la stratigraphie du Crétacé et la feuille de Tablat.* Acad. Sci., C. R., vol. 238, pp. 498-500.

CHEYLAN, G., AND MAGNÉ, J.
1954 – *Observations nouvelles sur le Jurassique et le Crétacé de la région de Lalla Aouda (Feuille Orléansville, Algérie).* Soc. Hist. Nat. Afrique du Nord, Bull., vol. 45, no. 3-4, pp. 170-178.

CHEYLAN, G., MAGNÉ, J., SIGAL, J., AND GRÉKOFF, N.
1954 – *Résultats géologiques et micropaléontologiques du sondage d'El Krachem (Hauts Plateaux algérois); Description de quelques espèces nouvelles.* Soc. Géol. France, Bull., ser. 6, vol. 3 (1953), fasc. 4-6, pp. 471-492, 1 pl.

GLAÇON, G., AND GLAÇON, J.
1954 – *Sur la présence d'Éocène moyen et supérieur dans la région de Lafayette et d'Ain Roua au N. de Sétif (Algérie).* Acad. Sci., C. R., vol. 238, pp. 1053-1055.

MAGNÉ, J
1953 – *Aperçu des microfaunes caractéristiques des niveaux de l'Oued Guétérini.* In: ORTYNSKI, I., AND PUECH, J., *Un nouveau gisement de pétrole en Algérie: L'Oued Guétérini.* Congr. Géol. Internat., XIX (Alger, 1952), C. R., fasc. 16 (sec. 14), pp. 201-202.

MAGNÉ, J, AND SIGAL, J.
1954 – *Sur la position stratigraphique d'un niveau-repère à radiolaires (Albien élevé et Vraconien) en Algérie.* Soc. Géol. France, Bull., ser. 6, vol. 3 (1953), fasc. 4-6, pp. 345-353..

MAGNÉ, J., AND TEMPÈRE, C.
1953 – *Micropaléontologie de deux bassins néogènes algériens: Le Chélif et le Hodna; Applications aux recherches de pétrole.* Congr. Géol. Internat., XIX (Alger, 1952), C. R., fasc. 16 (sec. 14), pp. 147-176, 6 pls.

PERRODON, A., AND TEMPÈRE, C.
1954 – *Sur l'extension du Miocène dans les Seba Chioukh (Oranie occidentale, Algérie).* Soc. Géol. France, Bull., ser. 6, vol. 3 (1953), fasc. 7-8, pp. 583-588.

RIVOIRARD, R., AND SIGAL, J.
1954 – *Observations géologiques dans l'Atlas tellien près de Tablat (Département d'Alger).* Soc. Hist. Nat. Afrique du Nord, Bull., vol. 45, no. 5-6, pp. 254-265.

Tunisia

Work ceased at the S. N. A. P. in June of 1954. Mr. Dalbiez therefore left Tunisia and transferred to the Esso-Standard S. A. F. in Bordeaux, as a micropaleontologist. Mr. Dollé, of the C. P. D. T., has also left Tunisia. He has been replaced by Mr. Ford. Dr. Schijfsma left the S. E. R. E. P. T. in June, 1954, for a position as micropaleontologist with A. I. O. C. M. Mr. Glintzboeckel has taken charge of the laboratory and is mainly engaged in routine work.

Morocco

During 1954, about 6850 thin sections and 1350 residues from washing, collected from wells and field sections in the Petitjean and Moyenne Moulouya areas, were studied in the Petitjean laboratory of the Société Chérifienne des Pétroles. Biostratigraphic studies on the borders of the Miocene basin of Souk-el-Arba have been continued this year. They necessitated counting about 2,093,300 foraminifera, and resulted in 227 diagrams. The mounting of photologs of microfacies was intensified, and twenty-one photologs were set up during 1954. This method is very useful in the study of lateral variations in facies.

A catalogue of the principal microfacies encountered in the pre-Rif and the Moyenne Moulouya area is in the process of completion. It will be published, probably in English and French, by a Dutch publishing house. In col-

laboration with J. Sigal, a study of Jurassic foraminifera is being carried on, and a paper is in preparation. A paper entitled "Problèmes micropaléontologiques posés par la limite Crétacé-Tertiaire" was submitted by Mr. Rey to the Comité National Français du 4ème Congrès Mondial du Pétrole, to be included in the French contributions on this problem. Mr. Rey was in Algiers from May 7th to 9th, 1954, to attend the Congrès National du Pétrole Français. He presented a paper entitled "Emplois des photologs de microfaciès." During his stay, he visited the stratigraphic laboratories of S. N. REPAL and C. F. P. A.

Recent publications

DARDENNE, M.
1954 – *Paléontologie et écologie du Miocène marocain (région du Zegotta).* Morocco, Service Géol Notes et Mém., no. 121, pp. 31-69.

FALLOT, P., AND REY, M.
1953 – *Les formations gréseuses du cap Spartel.* Morocco, Service Géol., Notes et Mém., no. 117, pp. 73-87.

REY, M.
1954 – *Sur l'emploi des photo-logs de microfaciès dans les séries indurées sédimentaires traversées par les sondages.* Inst. Franç. Pétrole, Rev., vol. 9, no. 2, pp. 39-41.

1954 – *Comparaison des microfaunes du Nummulitique nord-marocain et du Nummulitique du golfe du Mexique et de la mer des Caraïbes.* Congr. Géol. Internat., XIX (Alger, 1952), C. R., fasc. 19 (U.P.I.), pp. 39-60.

1955 – *Description de quelques espèces nouvelles de foraminifères dans le Nummulitique nord-marocain.* Soc. Géol. France, Bull., ser. 6, vol. 4 (1954), fasc. 4-6, pp. 209-211.

MARCEL REY
Société Chérifienne des Pétroles
Petitjean, Morocco

PORTUGAL

JAIME MARTINS FERREIRA

Work in micropaleontology is progressing slowly because of a lack of basic literature. In the Faculty of Sciences of the University of Lisbon, Miss Maria Manuela Castelo is studying the diatoms of the Alfarims deposits. A. T. Rocha and your correspondent are making a micropaleontological study of some fossiliferous deposits at Lisbon and Peniche. In the course of this work, they found some forms of "*Lagena* X" resembling those described by J. H. van Voorthuysen in The Micropaleontologist (1949, vol. 3, no. 2). They have written to inform Dr. van Voorthuysen of this interesting discovery, and hope to publish a note on it in the near future.

Recent publications

COLOM, G. AND CARVALHO, G. S.
1954 – *Contribuição para o estudo da micropaleontologia dos depósitos detriticos Pliocénicos de Portugal.* Coimbra, Univ., Mus. Lab. Min. Geol., Mem. e Not., no. 37, pp. 37-60, pls. 1-4, tf. 1.

ROCHA, A. T., AND FERREIRA, J. M.
1953 – *Estudo dos foraminíferos fósseis do Pliocénico da região de Pombal.* Lisbon, Univ., Fac. Ci., Rev., ser. 2, C, vol. 3, fasc. 1, pp. 129-156, pls. 1-3.

1954 – *Foraminíferos fósseis do tunel do Rossio.* Las Ciências, Madrid, vol. 19, no. 2, pp. 345-348.

[MS.] *Estudo dos foraminíferos fósseis das argilas azuis com "Nonionella atlantica" Cushman de Cabo Ruivo.* Las Ciências, Madrid (in press).

JAIME MARTINS FERREIRA
University of Lisbon
Portugal

SAUDI ARABIA

C. D. REDMOND

As always, news from Saudi Arabia is restricted in quantity because the Arabian American Oil Company is the only organization operating in this area. However, it is a pleasure to report that Dr. Esther Aberdeen Holm, wife of D. A. Holm, one of Aramco's senior geologists, is now located in Dhahran. Mrs. Holm is working in the Company's Research Division and, in addition to this, has accepted a post with the University of Maryland's Overseas Program. She will teach a course in economic geography, delivering lectures in Abqaiq, Dhahran and Ras Tanura.

It is also a pleasure to report the presence of Robert W. Morris, who transferred to Saudi Arabia from the Standard Oil Company of California. Mr. Morris is working principally with the Ostracoda. Robert W. Wacker, a New York University graduate, who has been attached to the Structure Drill section for the past five years, has been transferred to Dhahran and will assist the writer in research on stratigraphic problems.

C. D. REDMOND
Arabian American Oil Company
Dhahran, Saudi Arabia

PLANT MICROFOSSILS

News

A very successful and thought-provoking symposium concerning spores, pollen and other microfossils useful in oil exploration was held at the joint meetings of the A. A. P. G., S. E. G. and S. E. P. M. on March 30, 1955, in New York City. The presiding chairmen were Drs. W. S. Hoffmeister and Elso Barghoorn. The following program was presented, and spirited discussions followed a number of the papers.

1. *Spores and pollen—A new stratigraphic tool for the oil industry.* Raymond D. Woods, Humble Oil and Refining Company.
2. *Mississippian plant spores from the Hardinsburg formation of Illinois and Kentucky.* W. S. Hoffmeister, Frank L. Staplin and Raymond E. Malloy, Carter Oil Company.
3. *Stratigraphic distribution of Pennsylvanian spores.* Robert M. Kosanke, Illinois State Geological Survey.
4. *Stratigraphic correlation in Paleozoic strata.* Gerhard Kremp, Pennsylvania State University.
5. *Tertiary spores and pollen related to paleoecology and stratigraphy of California.* W. L. Norem, California Research Corporation.
6. *Morphology and geology of the Hystrichosphaerida.* L. R. Wilson, University of Massachusetts, and W. S. Hoffmeister, Carter Oil Company.
7. *Micropaleontology of holothurian sclerites.* Don L. Frizzell, Missouri School of Mines.

Program on systematic methods

A one-day round-table program is being sponsored by the Paleobotanical Section of the Botanical Society of America. It is to be held on the campus of Michigan State College, East Lansing, Michigan, in conjunction with the Botanical Society of America and the A. I. B. S. meetings September 5-9, 1955.

The purpose of the program is to afford a complete coverage of the world literature affecting the systematic treatment of plant microfossils, chiefly spores and pollen. Stratigraphically, the Paleozoic and Meso-Cenozoic is to be covered. Each speaker is to introduce and review the subject matter of one of the six subdivisions of the round-table topic. Informal discussion will follow each presentation.

The exact date for this round-table program has not been set. Most likely, it will be September 5th or 6th. For those interested in attending, the date and complete program will be published in the August issue of the A. I. B. S. Bulletin under the Paleobotanical Section of the Botanical Society of America. The program moderator will be James A. Schopf.

MESO-CENOZOIC MATERIALS

Methods used by German, Dutch and French investigators:

Discussion leader . . . W. Spackman, Jr.
First-hand observations . . . . G. O. Kremp
Comments on European Tertiary pollen studies . . . . . . C. A. Brown

Methods of Australian, New Zealand, Indian and Soviet investigators:

Discussion leader . . . . . A. F. Traverse

PALEOZOIC MATERIALS

Methods of German, Dutch and French investigators:

Discussion leader . . . . . G. H. Guennel
First-hand observations . . . . G. O. Kremp

Methods of Australian, Indian and Soviet investigators:

Discussion co-leaders . . . . . A. T. Cross and M. P. Schemel

GENERAL

Methods of British and American investigators:

Discussion co-leaders . . . L. R. Wilson and W. S. Hoffmeister

New addresses

Benninghoff, William L., Geological Division, U. S. Geological Survey, Washington 25, D. C.

Grayson, John L., Magnolia Petroleum Company, Field Research Laboratory, P. O. Box 900, Dallas, Texas.

Kremp, Gerhard, Geology Division, School of Mineral Industry, Pennsylvania State University, University Park, Pennsylvania.

LeBlanc, Arthur E., Box 362, Midland, Texas.

Traverse, Alfred, Fuels Microscopy Laboratory, Building 20, Federal Center, Denver 2, Colorado.

Work in progress

Elso S. Barghoorn is working with Mrs. Grace Bush on the determination of the botanical affinities of certain Paleozoic spores isolated from known fructifications. This study is in connection with Mrs. Bush's Ph.D. thesis, which will probably be completed by February, 1956. Dr. Barghoorn is also working with Stanley A. Taylor, on microfossils from Middle Huronian rocks of the Canadian Shield; with Donald Whitehead, on spores and pollen from organic sediments in the Piedmont of North and South Carolina; and with Margaret Wolfe, on spores and pollen from two 1400-foot cores through the Upper Cretaceous of Long Island.

W. S. Benninghoff is engaged in pollen studies of Quaternary peats from central Alaska. He is also working on pollen in Alaskan Tertiary coals. John F. Grayson is studying the Pleistocene palynology of Labrador, and pre-Pleistocene palynology in connection with petroleum exploration. G. K. Guennel is carrying out a miospore analysis of Pottsville and Millersburg coals in Indiana, and a megaspore study of Indiana block coals. W. S. Hoffmeister is working with Frank L. Stapin and Ray E. Malloy on Mississippian plant spores from the Hardinsburg formation in Illinois and Kentucky. Arthur S. Knox is studying spores and pollen from Cretaceous beds on Block Island, Rhode Island. Alfred Traverse is work-

ing with William Spackman on a palynological study of certain peats of Georgia and Florida.

L. R. Wilson is working with Norman Erickson on the hystrichosphaerids of the Onondaga limestone (Devonian), and with John Fisher on those of the Clinton group (Silurian). Dr. Wilson is also working with Robert Hulsman on microfossils from Recent sediments of Lake Maracaibo, Venezuela, and with W. S. Hoffmeister on Pennsylvanian spores in Oklahoma coals.

Recent literature

ANDERSEN, S. H.
1954 – *A late-glacial pollen diagram from southern Michigan, U. S. A.* Danmarks Geol. Unders., ser. 2, no. 80, pp. 140-155.

ANDREWS, H. N., JR.
1955 – *Index of generic names of fossil plants, 1820-1950.* U. S. Geol. Survey, Bull. 1013.

ARNOLD, C. A.
1955 – *A Tertiary Azolla from British Columbia.* Michigan, Univ., Mus. Pal., Contr., vol. 12, no. 4, pp. 37-45, 2 pls.

BARGHOORN, E. S., WOLFE, M. K., AND CLISBY, K. H.
1954 – *Fossil maize from the valley of Mexico.* Harvard Univ., Bot. Mus. Leaflets, no. 16, pp. 229-240.

BENNINGHOFF, W. S.
1954 – *Meetings of the Palynology Section (of the Eighth International Congress of Botany).* Micropaleontologist, vol. 8, no. 4, pp. 20-22.

1955 – *Quaternary vegetation of central Alaska.* Internat. Congr. Bot., 8th (Paris), Proc.

1955 – *Taiga and physical factors of the sub-arctic environment.* Internat. Congr. Bot., 8th (Paris), Proc.

1955 – *Jökla Mys.* Jour. Glaciol., vol. 2, no. 17, pp. 514-515.

BORGE, O., AND ERDTMAN, G.
1954 – *On the occurrence of Pediastrum in Tertiary strata in the Isle of Wight.* Bot. Not., vol. 2, pp. 112-113.

CHALONER, W. G.
1954 – *Mississippian megaspores from Michigan and adjacent states.* Michigan, Univ., Mus. Pal., Contr., vol. 7, pp. 23-25, 2 pls., 1 tf.

COUPER, R. A.
1953 – *Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand.* New Zealand, Geol. Survey, Pal. Bull., no. 22.

DANSEREAU, P.
1954 – *The postglacial pine period.* Roy. Soc. Canada, Trans., vol. 47, pp. 23-38.

ERDTMAN, G.
1954 – *On pollen grains and dinoflagellate cysts in the Firth of Gullmarn.* Bot. Not., vol. 2, pp. 103-111.

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Paul B. Sears
Yale University
New Haven, Connecticut

L. R. Wilson
University of Massachusetts
Amherst, Massachusetts

Directory of correspondents

The following list of correspondents is presented for the benefit of those who wish to submit news items for publication in this quarterly. Contributors should send such news items to the correspondents reporting for their own areas. Manuscripts of papers submitted for publication should *not* be sent to correspondents. They should be directed to: Department of Micropaleontology, American Museum of Natural History, Central Park West at 79th Street, New York 24, N. Y.

Australia

IRENE CRESPIN
Bureau of Mineral Resources
Civic Centre
Canberra, A.C.T., Australia

Austria

RUDOLF GRILL
Geologische Bundesanstalt
Rasumofskygasse 23
Vienna III/40, Austria

Benelux

J. H. VAN VOORTHUYSEN
Geologische Stichting
Spaarne 17
Haarlem, Netherlands

Brazil

FREDERICO W. LANGE
Caixa Postal, 16
Ponta Grossa, Paraná, Brazil

Colombia

VICTOR PETTERS
Exploration Department
International Petroleum (Colombia) Ltd.
Bogotá, Colombia

East Indies

GEORGE A. DE NEVE
Tjibeunjiplein Zuid 31
Bandung, Java, Indonesia

Egypt

RUSHDI SAID
140, Sh. Teraa el-Boulakia
Cairo, Egypt

France

JEAN CUVILLIER
Laboratoire de Géologie Appliquée
Université de Paris
191, Rue St. Jacques
Paris, France

Germany

HEINRICH HILTERMANN
Amt für Bodenforschung
Wiesenstrasse 72
Hannover, Germany

Great Britain

TOM BARNARD
University College
Gower Street
London W.C.1, England

India

S. R. N. RAO
Department of Geology
University of Lucknow
Lucknow, India

Israel

Z. REISS
Laboratory of Micropaleontology
Geological Institute of Israel
Jerusalem, Israel

Italy

ENRICO DI NAPOLI ALLIATA
American International Fuel and Petroleum Company
Via XX Settembre N. 5
Rome, Italy

Japan

K. ASANO
Institute of Geology and Paleontology
Tohoku University
Sendai, Japan

Mexico

CLEMENCIA TÉLLEZ-GIRÓN
Petróleos Mexicanos
Laboratorio de Paleontologia
Ciprés no. 176
Mexico 4, D.F., Mexico

Middle East

MAX CHATTON
Qatar Petroleum Company Ltd.
Dukhan, Qatar
via Bahrein Island, Persian Gulf

New Zealand

N. DE B. HORNIBROOK
New Zealand Geological Survey
156, The Terrace
Wellington, New Zealand

North Africa

MARCEL REY
Société Chérifienne des Pétroles
27, Avenue Urbain Blanc
Petitjean, French Morocco

Peru

LAWRENCE WEISS
International Petroleum Company, Ltd.
Talara, Peru

Poland

FRANCISZEK BIEDA
Zaklad Paleontologii A.G.-N.
ul. Grodzka 53
Kraków, Poland

Portugal

JAIME M. FERREIRA
Avenida Duque de Loulé 50 – 1°
Lisbon, Portugal

Colonial Portugal

ARMENIO T. ROCHA
Avenida Almirante Reis 151 – 3° E
Lisbon, Portugal

Saudi Arabia

C. D. REDMOND
Arabian American Oil Company
Dhahran, Saudi Arabia

Scandinavia

FRITZ BROTZEN
Geological Survey of Sweden
Stockholm 50, Sweden

Spain

G. COLOM
Isabel II, 23
Soller, Mallorca, Spain

Switzerland

MANFRED REICHEL
Geologisch-Paläontologisches Institut
Universität Basel
Basel, Switzerland

Turkey

A. SUAT ERK
Maden Tetkik ve Arama Enstitüsü
Ankara, Turkey

United States, Eastern

ALFRED R. LOEBLICH, JR.
U. S. National Museum
Washington 25, D. C., U. S. A.

United States, Gulf Coast

STUART A. LEVINSON
Humble Oil & Refining Company
P. O. Box 2180
Houston 1, Texas, U. S. A.

United States, Mid-Continent

DOROTHY JUNG ECHOLS
Department of Geology and Geological Engineering
Washington University
St. Louis 5, Missouri, U. S. A.

United States, North-Central

R. M. STAINFORTH
The Carter Oil Company
P. O. Box 318
Billings, Montana, U. S. A.

United States, Western

HANS E. THALMANN
Department of Geology
Stanford University
Stanford, California, U. S. A.

Venezuela

J. G. BURSCH
c/o Phillips Venezuelan Oil Company
Apartado de Correos 1031
Caracas, Venezuela

West Indies

PAUL BRONNIMANN
c/o Cuban Gulf Oil Company
Apartado 729
Havana, Cuba